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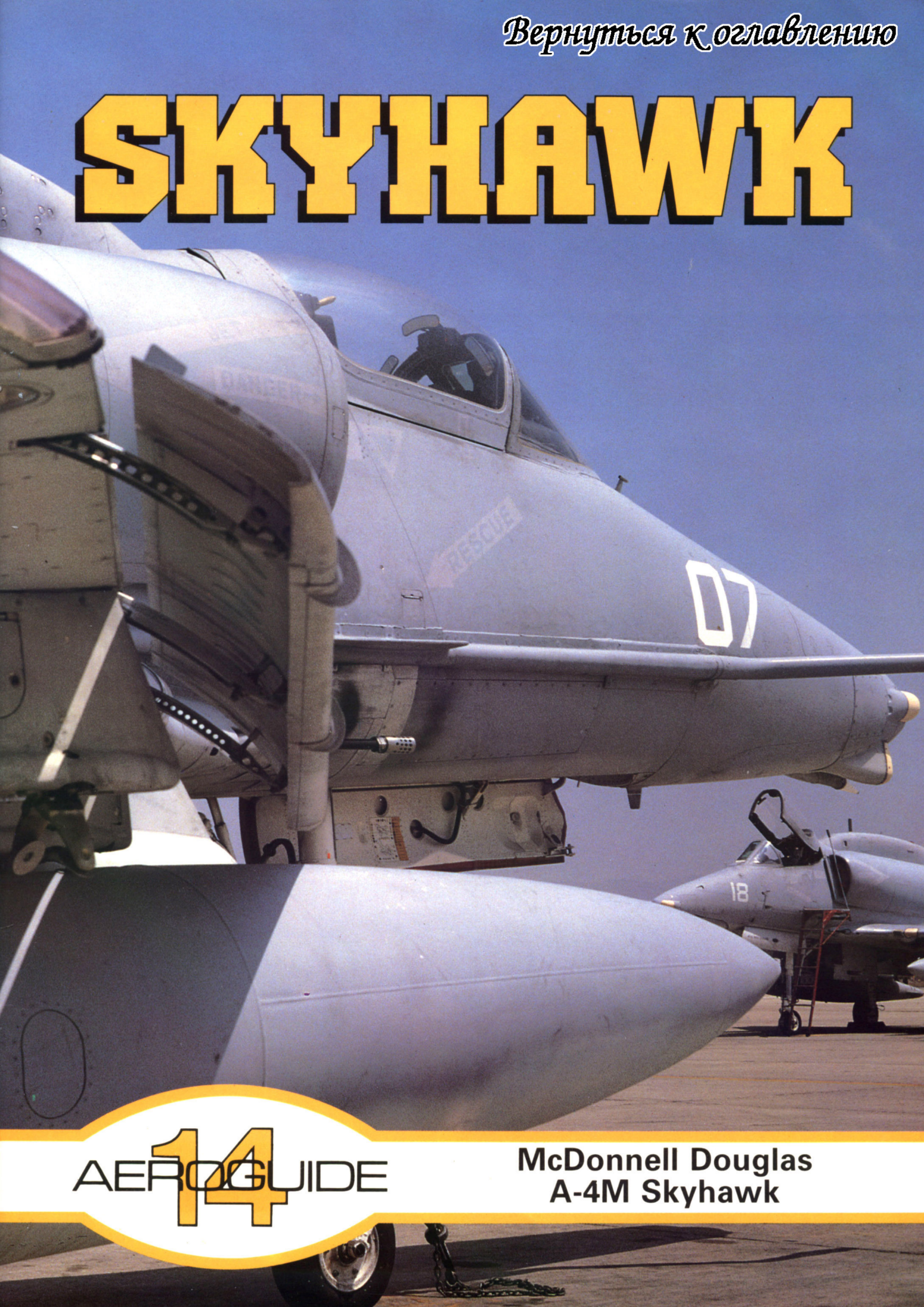
SKYHAWK



AEROGUIDE 14

McDonnell Douglas
A-4M Skyhawk

AEROGUIDE 14: McDONNELL DOUGLAS A-4M SKYHAWK

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Cover photo: A pair of A-4M Skyhawks assigned to VMA-311 'Tomcats', MCAS El Toro, May 1985. One aircraft has white nose codes, the other pale grey.

Back cover plate: An A-4M of VMA-311 in more colourful decor, June 1977.

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McDonnell Douglas A-4M Skyhawk

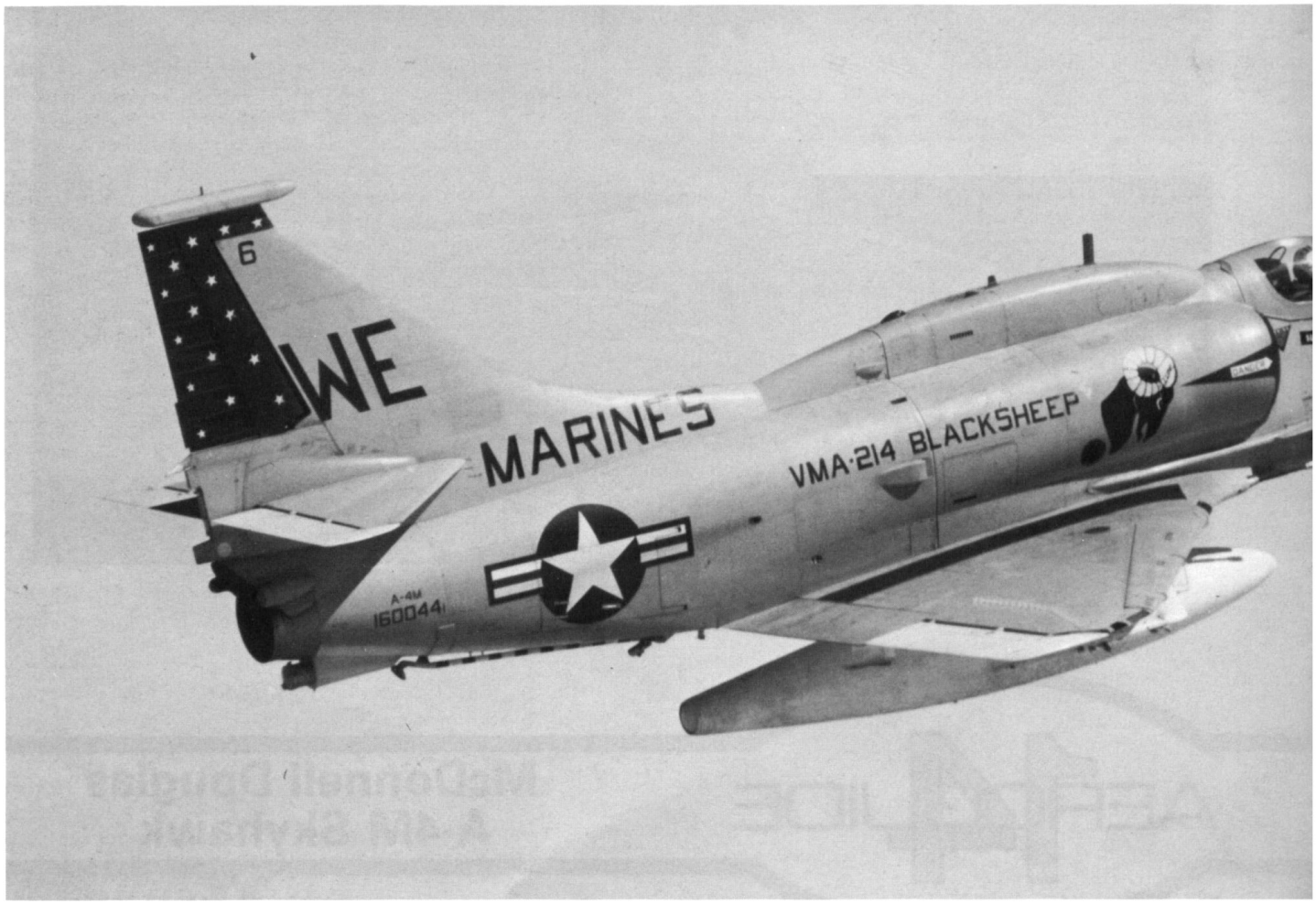
INTRODUCTION

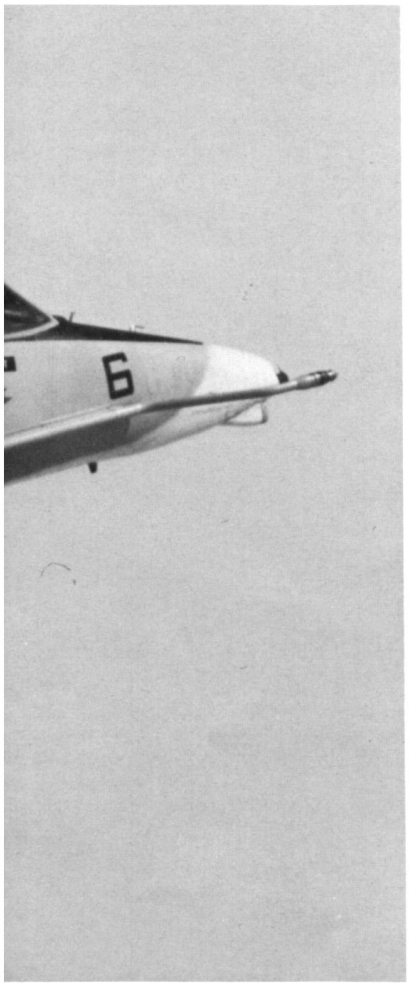
The evolution of military aircraft is not much different from the evolution of anything else in one important respect: each succeeding product is an improvement, or is planned to be an improvement, on what already exists. A new aeroplane, therefore, might be faster than the one it is designed to replace; it can perhaps carry a greater quantity, or variety, of weapons; it can possibly fly further; it might have better equipment inside it to help the pilot do his job more effectively; it may handle more efficiently in the air. It could show a combination of any or all of these things, and of other features too – and so it should, since, if it doesn't, the argument for building it in the first place starts to wear a bit thin. The trouble is that improvements have a cost – not just in financial terms, but also in terms of aircraft weight, volume and complexity. Even this is too easy, because every factor in aircraft design has implications for a whole host of others.

Take, for example, increased range. One obvious solution here is going to be greater internal fuel capacity. Assuming you don't wish to impair any of the aircraft's other virtues, this will inevitably mean more space devoted to wing tanks or fuselage tanks, and hence larger wings or a bigger fuselage. The aircraft will now, therefore, be heavier than it was, and will probably need a more powerful engine if a drop in performance is to be avoided. More thrust will as likely as not require a bigger engine, so the fuselage or whatever will need to be bigger still to accommodate it. Big engines tend to drink more, so fuel capacity will have to be increased again in order to maintain range; this can probably be organised (say) by building larger wings – which might be necessary in any case to maintain aerodynamic efficiency with the heavier fuselage. Then the undercarriage may have to be beefed up to carry the added airframe weight, and perhaps the stability of the aircraft will have to be improved (a bigger fin?), and then what about . . .?

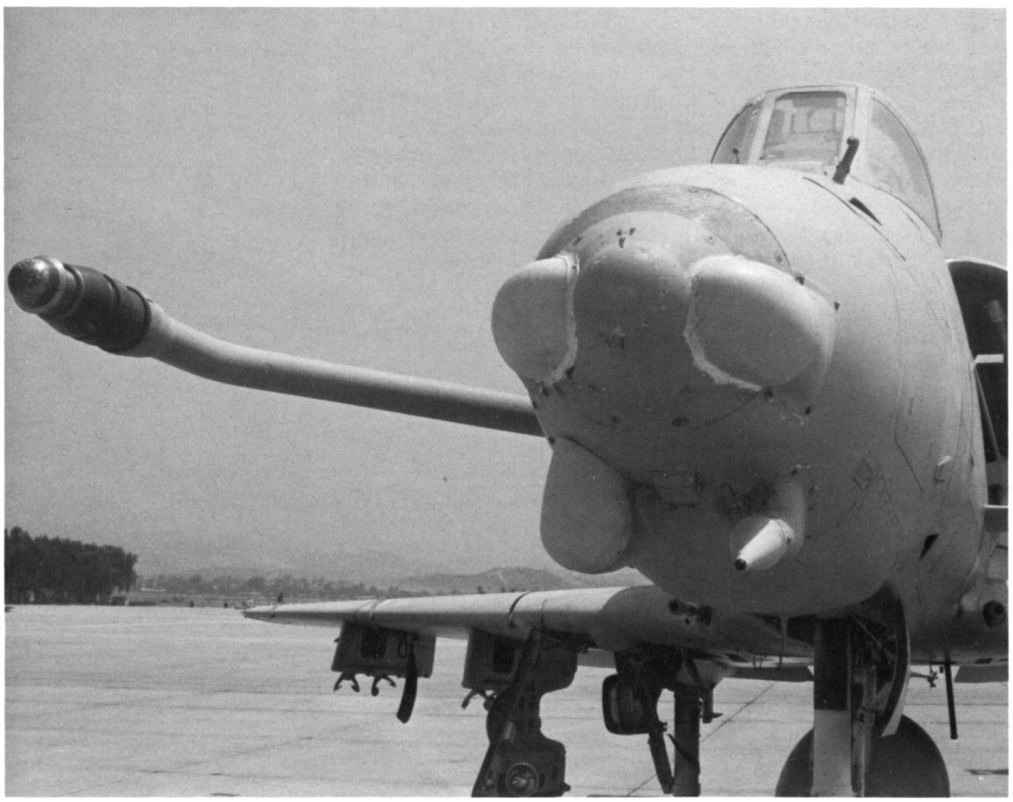
Nowadays, 'fuel efficiency' and 'weight-saving' are two of the buzz-terms in the aerospace industry, and very small, incredibly economical turbofan engines and marvellous high-tech composite materials are available to meet these ends, but thirty-five years ago there seemed to be no obvious solution to the problem of keeping ahead of the opposition with ever-improved aircraft without invoking a dizzy spiral of weight/size/cost/complexity. The scene sketched out above is simplistic, but the fundamental argument is sound enough.

At El Segundo, California, the Douglas Aircraft Company design team recognised the difficulty all right. Led by 'Ed' Heinemann, the Chief Engineer, they decided to do something about it. They had not come up with any amazing technological breakthrough: they simply took the problem and turned it the other way round. If, for example, you needed all that extra weight – airframe, fuel, engine, and the added infrastructure that these implied – just to increase the distance an aircraft could fly, then every scrap of unnecessary weight you did away with would surely have the same effect: actually *reducing* the fuel capacity would *reduce* all the other design factors, and it was thus conceivable, indeed likely, that by judiciously paring at the 'fixed' elements of the design you need not sacrifice range at all – in fact you might even increase it. Thanks to the energies and persistence of Heinemann, the theory was put to the test, and the resulting aircraft, the Douglas Skyhawk, is one of the most remarkable achievements in the history of aviation.





Above: A-4M Skyhawks from VMA-311 ('Tomcats') fly in close formation. The photo was taken in 1977. *Harry Gann/McDonnell Douglas*
Left: A VMA-214 A-4M, seen in 1979. Neat, compact and manoeuvrable, the Skyhawk has always been popular with its pilots, earning itself such affectionate names as 'Scooter', 'Bantam Bomber' and, in a reference to its chief designer, 'Heinemann's Hotrod'. *McDonnell Douglas*
Below: Characteristic cranked refuelling boom on a blister-nosed A-4M Skyhawk, 1985.



DESIGN & DEVELOPMENT

The A-4M was towed from an adjacent building into view of the audience as details of the Skyhawk program were narrated by Robert F Canaday, Douglas' director of international government marketing . . . [John C] Brizendine [President, Douglas Aircraft Company] and Edward Heinemann, former chief designer at the one-time company facility at El Segundo, then presented the log books for the last A-4 to Captain E W Melvin USN, Navy plant representative at Douglas . . . The log books were then handed by Capt Melvin to Lt Col M R Snedecker USMC, commanding officer of VMA-331 . . . Three other Skyhawks were parked on the ramp as a backdrop for the ceremony . . . Program participants included the Marine Corps color guard and the Third Marine Air Wing band . . .'

Back in 1951 few would have imagined that the production run for something called the Skyhawk would span nearly 26 years and involve almost 3000 aircraft. In that year, many at the Douglas Aircraft Company were beginning to feel a bit fed up, although judging from the number of different aircraft projects under way at El Segundo one would hardly think this possible. The piston-engined AD Skyraider was in great demand for the conflict in far-away Korea; the jet-powered F3D Skyknight all-weather fighter, also sent to Korea, was showing considerable promise in the hands of the Marines; the twin-jet A3D Skywarrior strategic nuclear bomber prototype was well advanced and production aircraft were gleefully awaited by the Navy; and the F4D Skyray, the company's radical high-speed interceptor for the Navy, had just flown for the first time and was on the point of proving what an excellent machine it was. What, then, was the problem? Answer: turboprops.

Lots of interesting technology had become available since the Skyraider was designed in 1942–43, and although the 'Able Dog' was proving to be an outstanding asset in the close-support role in Korea it was decidedly World War II-ish and not quite the thing in this day and age. Something better was needed. Jet aircraft could streak across the sky but they couldn't carry much in the way of a warload; piston aircraft (the AD included) could heave around everything *including* the kitchen sink but were so slow that they were liable to be picked off by ground fire before you could say knife. An aeroplane powered by a turboprop, on the other hand, would be both fast (well, quite fast) and capable. This was the Navy's thinking, and this was what Douglas were straining every nerve to achieve. Their project was the A2D Skyshark, and in 1950 the maiden flight had gone smoothly enough, but within a few months one of the prototypes crashed. All sorts of problems were being experienced with the complicated gearing mechanism controlling the contra-rotating propellers and the XT40 powerplant, and the more effort was spent trying to cure the trouble the worse it seemed to get.

It was about this time that the Douglas theory of aircraft weight reduction was being studied – cut the empty weight of an aeroplane down to the bare essentials, and a much greater percentage of the gross weight will be available for lifting capacity (in other words fuel and weapons). The plan originally envisaged was the application of the principle to a jet fighter, but while Heinemann was haranguing Bureau of Aeronautics representatives in Washington with his ideas early in 1952 he was asked if the concept was valid also for jet bombers. He replied that it was, and BuAer called his bluff.

Much to the relief of all concerned, the Skyshark project was swiftly consigned to the scrap heap, even though the remaining prototype continued testing for a year or so more and a handful of other airframes were put together, and Douglas' design team turned their thoughts to the new lightweight aircraft. This would do the job previously earmarked for the A2D – carrier-based dive-bombing, close support and interdiction against either land or sea targets, using conventional or 'special' (*ie* nuclear) weapons. Douglas set themselves three major parameters: the new machine would be turbojet-powered, to give it high speed; it would have to be small enough to fit carrier lifts without any of that wing folding business, so as to cut out unnecessary extra weight and to avoid weakening the wing (which would serve as a single giant fuel tank); and it would gross not more than 12,000lb (roughly half the weight of the A2D). The last proved unattainable, since as preliminary design proceeded the Navy decided to specify JP5 jet fuel (which aircraft carriers could burn in their own boilers) for the new aircraft, adding about 10 per cent to the total weight allowance for fuel, and to increase the bomb load from 1000 to 2000lb.

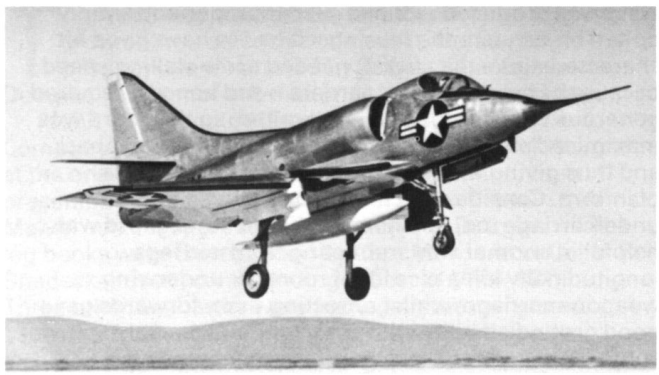
Right: A fine study of the prototype Skyhawk, designated XA4D-1. The aircraft was given the Bureau Number 137812, but at the time this photo was taken the stencilled digits, applied beneath the tailplane, were masked out. The aircraft was left in its natural metal finish, although the undersurfaces of the wing and tailplane were white; the cockpit anti-glare panel, the intake rims and the leading edges of the flying surfaces were black. *McDonnell Douglas*

The contract for two aircraft issued by the US Navy in June 1952 showed some other constraints, including a maximum unit cost of $1 million, a top speed of at least 500mph and a mission radius of 400nm – figures which left the design team at El Segundo unperturbed since they were pretty much what Douglas had in mind anyway.

Everything possible – and much held by many to be well-nigh impossible – was done to save weight. The 'factor of ten' was invoked and ruthlessly complied with. Heinemann was convinced that savings made even on seemingly insignificant items had an effect out of all proportion to their own weight – a proportion ten times greater in fact. For example, saving 5lb on a run of fuel piping would, by the time you took into account the additional savings on fittings, the amount of fuel needed to fill it, the valves, and so on, plus the reduction in aircraft gross weight and hence the need for less fuel anyway, result in a total saving of 50lb; at the other extreme, saving, say, 50lb by not using a wing fold mechanism had a dramatic effect, especially since you would have needed two of them.

Some features of the design could not really be pruned, notably the engine, but the calculations showed that the 7200lb thrust Wright J65 (licence-built Sapphire) would move the aircraft through the sky in the required manner, and this was one of the lightest powerplants around. The wing was produced as a one-piece component, simply bolted on beneath the fuselage. It had to have good lift characteristics – the aircraft needed a low stalling speed because of its use aboard carriers – and hence it required a generous wing area; span was limited, so the chord was maximised at the wing root, preserving the sweepback and thus giving the wing the appearance of a delta planform. Considerable thought was given to the undercarriage too, and here the broad inner chord was helpful in another way: retracting the main legs longitudinally left a nice lot of room for underwing weapons carriage, whilst retracting them forwards gave good ground stability with the gear down and also cut out some of the hydraulics, since in an emergency the undercarriage would swing down through gravity and get locked into position by the airstream. To preserve the strength of the wing the main gear struts would lie in external fairings, not totally enclosed within the wing in cut-out box housings.

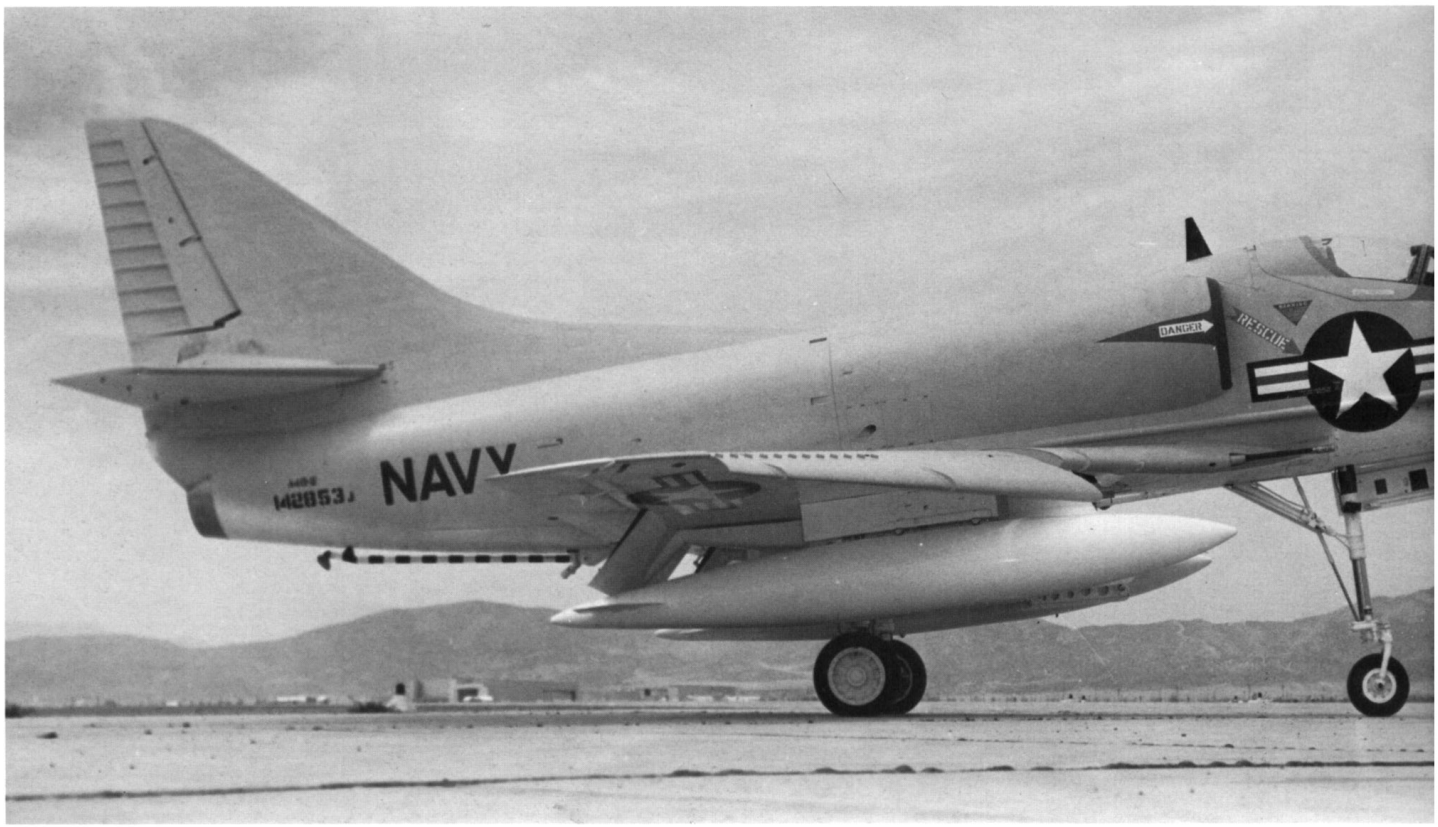
Throughout 1952 the design was prepared, amended, refined and fine-tuned, and in October that year Douglas got a contract for nineteen further aircraft, to be built to pre-production standards; these would be designated A4D (attack aircraft, fourth by Douglas) and powered by an uprated J65 of 7800lb thrust. At the same time Douglas got its ideas approved by the Navy and started to tool up. Just



over a year later, in February 1954, the XA4D-1 Skyhawk prototype was completed, and after a further four months of equipment fitting, ground testing and so on the aircraft, BuNo 137812, took off.

The A-4M Skyhawk flown today by US Marine Corps pilots is a much more capable aircraft than its silver coloured prototype that first flew all those years ago, although the basic shape is not all that different. The designation change is easily explained, because in 1962 all US Navy aircraft were brought into a new system which avoided any reference to the manufacturer. Douglas' AD (equivalent to 'A1D') became the A-1, the A3D became the A-3 and the A4D was changed to A-4. The suffix letter showed a change of mark, just as the suffix numeral had

Left above: The XA4D-1 Skyhawk first took to the air on 22 June 1954. Minor buffeting problems were experienced. *McDonnell Douglas*
Left: A view of the A4D-1 production line. The Skyhawk's three principal sub-assemblies – front fuselage, rear fuselage and wing – can be seen at top right. *McDonnell Douglas*
Below: One of the 542 A4D-2 Skyhawks built for the US Navy and Marine Corps. Many of these aircraft were later converted for use by Argentina, taking part in the 1982 Falklands War. *McDonnell Douglas*
Below right: A pair of A4D-2Ns (A-4Cs), in the markings of VA-195 ('Dam Busters'). *McDonnell Douglas*



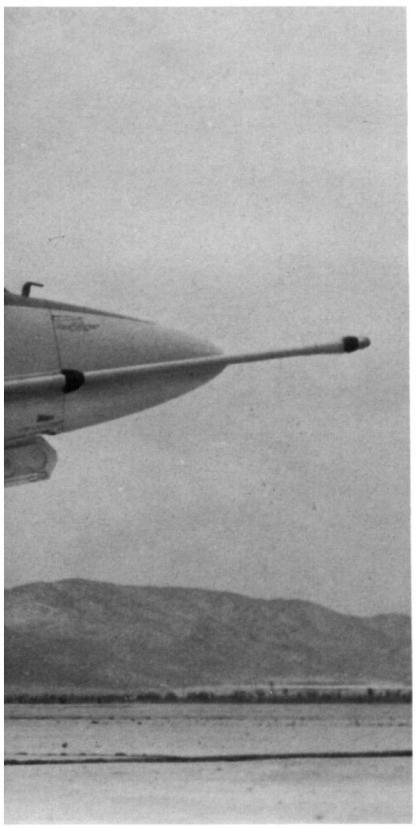
done in the past. The story behind the A-4M is more involved, as might be expected of a design with such a lengthy development history, although it is in principle a tale of progressively improved models, involving upgraded components and 'add on' features but surprisingly little in the way of major reconfiguration.

The A-4A (old designation: A4D-1) was the original production Skyhawk, first delivered to the US Navy in late 1956 and to the Marines early the following year. The A-4B (A4D-2) came along about a year later and could be easily spotted because it had a long in-flight refuelling boom sticking out at the front. Less obvious was its new rudder, prominently ribbed to cure a flutter problem experienced with the smooth-skinned type employed on the earlier mark, and not obvious at all were the greater strength of the airframe, the new bomb delivery systems, the back-up hydraulics and the revised avionics. An A-4B might also be seen toting Bullpup air-to-ground missiles, weapons denied to its predecessor.

Next was the A-4C, alias A4D-2N, which added significantly to the Skyhawk's range of activities, thanks to an ultra-light Westinghouse radar system mounted in the remodelled front fuselage, the black nose tip to which was a reliable distinguishing feature of the new aircraft. The main function of the radar, designated APG-53, was terrain clearance, enabling the pilot to fly fast and low in relative safety, and it also gave the Skyhawk something of a night-time/bad weather capability though not much. Other systems were installed as well, including for example an AFCS (automatic flight control system) and blind- and low-altitude-bombing equipment. First deliveries of this variant (which, with well over 600 built, was produced in greater quantity than any other) took place in early 1960. The A4D-3 was stillborn. It would have got the A-4C tag had it not been cancelled, but the A4D-2N was produced instead because it didn't need the Pratt & Whitney J52 engine, which at the time was considered to be an unaffordable luxury. An A4D-2N model with a J52 (A4D-4) was also a non-starter, but the new powerplant eventually came on to the scene with the A4D-5, better known as the A-4E.

It will be apparent that by this time the hitherto sacrosanct 'factor of ten' was taking a bit of a battering. The J65 now being used was the uprated W-20 version, which produced 8500lb, but the 400nm mission radius was threatening to get down near the 300nm mark with all the extra weight that had to be carried. The J65 had precious little 'stretch' left in it, so the decision was made to go for the J52 after all: as well as being a more fuel-efficient powerplant, this engine was only just beginning to realise its potential and had a good programme mapped out for its future development. Initially it gave 8500lb like the final versions of the J65, but confidence was such that all sorts of extra bits and pieces were already earmarked for installation in the A-4E.

Another hurdle had been overcome, but after the Skyhawk had been blooded in combat over Vietnam certain shortcomings revealed themselves and still more equipment, especially electronic warfare gear, was shown to be necessary. The weight of this could be accepted, given the beefed-up structure of the A-4E and a developed engine, but now there was a different snag: instead of being just weight-critical, the aircraft was now very plainly volume-critical as well. In other words, although full account of the requirement to save weight wherever possible had been taken right through the Skyhawk's ten-year development sequence, the volume occupied by still more equipment just wasn't available – there simply wasn't room for it. There was no alternative but to fix it on to the outside of the aircraft, and the obvious place was the top of the fuselage, underneath an aerodynamic fairing. This arrangement came along with the A-4F, which began to be sent out to the squadrons in mid-1967. The avionics hump also started to appear on other Skyhawks in service, the A-4C (which, thus configured, became known as the A-4L) and the A-4E (which stayed as the A-4E). A-4Fs showed other changes, including an improved J52, first the 9300lb thrust P-8A and later the



11,200lb P-401, the latter needing redesigned main intakes; a zero-zero Escapac ejection seat (*ie* one that would save the pilot even from a stationary aircraft sitting on the flight deck); cockpit armour; and wing spoilers.

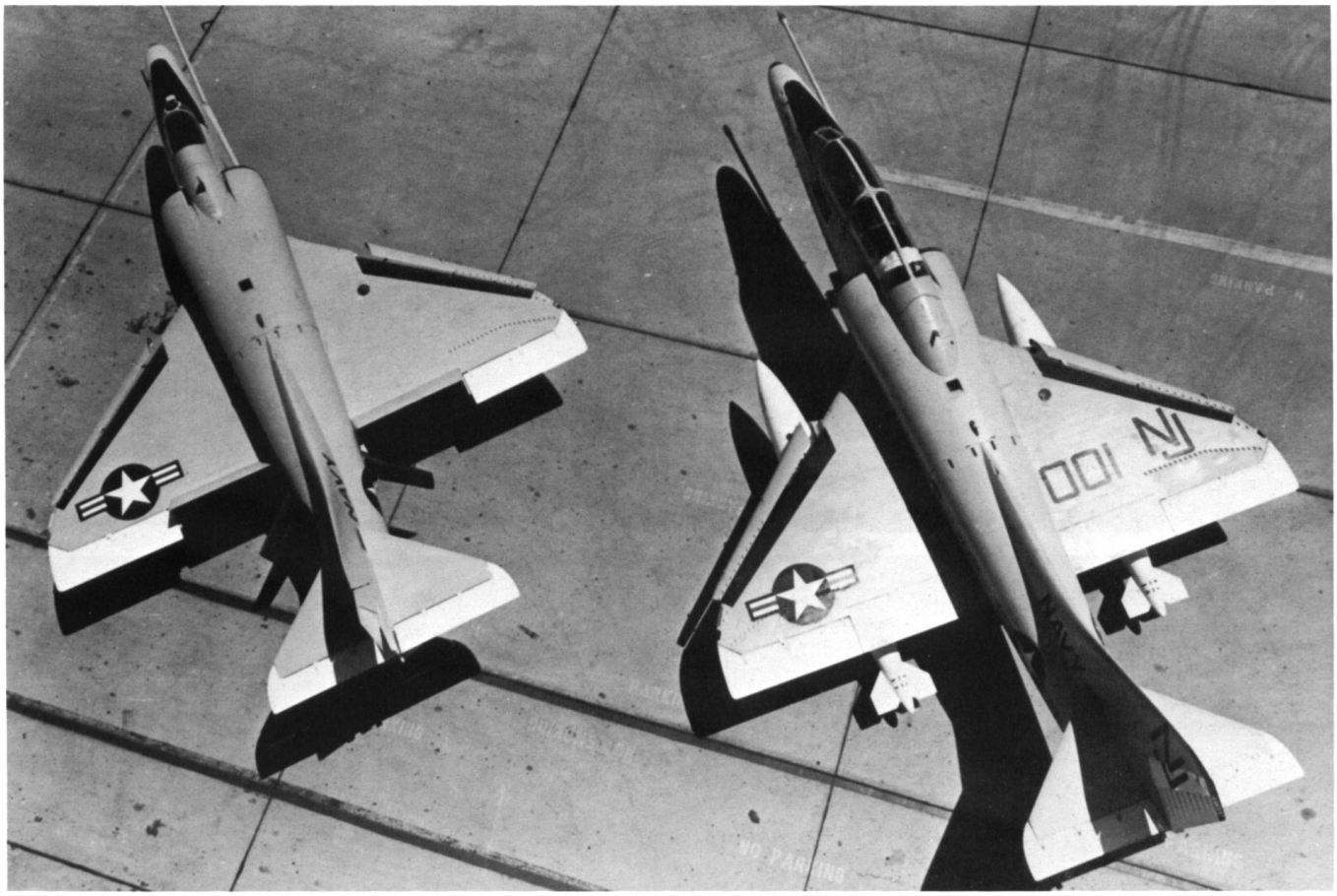
By the time the A-4F was achieving operational status a parallel two-seat trainer project was well in hand. The TA-4F, at first referred to as the TA-4E, was basically an A-4E with an extended front end to accommodate student and instructor in tandem beneath a vastly enlarged canopy, the price being a reduction in fuel capacity. It had the new P-8A engine, it had the ejection seats and wing spoilers already selected for the A-4F, and it beat the single-seater into service by a year. A second Skyhawk trainer came along later, designated TA-4J; paradoxically, this reverted to the P-6 engine of the A-4E, mainly because the aircraft was needed only for advanced flying training and didn't have to carry weapons training equipment and the associated avionics and thus could manage without the extra thrust. Most TA-4Js were converted from TA-4Fs.

Douglas had by now established a nice line in A-4 exports, but so far as the US Navy, the US Marine Corps and the Skyhawk were concerned that seemed to be that. A-4Gs and TA-4Gs had been organised for the Royal Australian Navy, work was going ahead with the A-4H/TA-4H for Israel and the A-4K/TA-4K package was being put together for New Zealand, whilst Argentina had some time beforehand requested refurbished, ex-US stock A-4Bs, which emerged as A-4Ps, and wanted some more. The reason for the idea that the end of the US line had finally been reached was the Navy's 1963 VAL (Light Attack Aircraft) competition. Looking ahead to the 1970s, the Bureau of Naval Weapons (successor to BuAer) decided that the Skyhawk would need to be replaced with something that could lift more weapons and take them further (though not necessarily faster), and, having taken them, plant them more accurately. Plainly, nothing more could be bolted on to the A-4, and so a completely fresh design was necessary. Douglas submitted some proposals, as did Grumman and North American, but it was the A-7 Corsair from Ling-Temco-Vought that got the nod, and from the late 1960s this would be the aircraft to re-equip all the Navy and Marine Corps Skyhawk squadrons.

But the Marine Corps had second thoughts. There can't be many instances of a service turning down an aircraft because the latter was too capable, but in essence this was what happened with the USMC and the A-7. The complexity of the Corsair would mean far more resources having to be devoted to the aircraft on the ground by way of maintenance and so on, whilst the promised 600nm radius tended to take the 'close' out of close air support, which was the capability the Marines required. One also suspects that, with a price tag for an A-7 outstripping by some margin that for a Skyhawk (which even in the mid-1960s was still being turned out for not much more than $1million a copy), a possible reduction in aircraft numbers was another anxiety. Moreover, by going their own way, the Marines could get a new machine tailored exactly to their requirements. And a new machine it was, even though it was still called a Skyhawk.

Appropriately (but quite coincidentally) suffixed 'M', the rejuvenated A-4 was easily the most potent of what had already become a distinguished family. The powerplant selected was the J52-P-408A, a development of the P-401 being retrofitted to some A-4Fs which offered the same thrust but even better fuel economy. The improvements went a good deal further. The 20 per cent extra thrust over the J52-P8A brought with it much increased acceleration,

Below: Steam rises from the slot as a US Navy A-4C is readied for take off on one of the carrier *John F Kennedy*'s catapults. *US Navy*
Right above: Single-seat and two-seat Skyhawks pose side by side, showing the wing planform to advantage. Though lacking its dorsal 'hump', the aircraft on the left is an A-4F, as evidenced by its raised spoilers; the trainer is a TA-4F. *McDonnell Douglas*
Right below: Skyhawks at sea: six can be counted on deck in this 1969 view of the carrier *Bon Homme Richard* (CVA-31) off Vietnam. *US Navy*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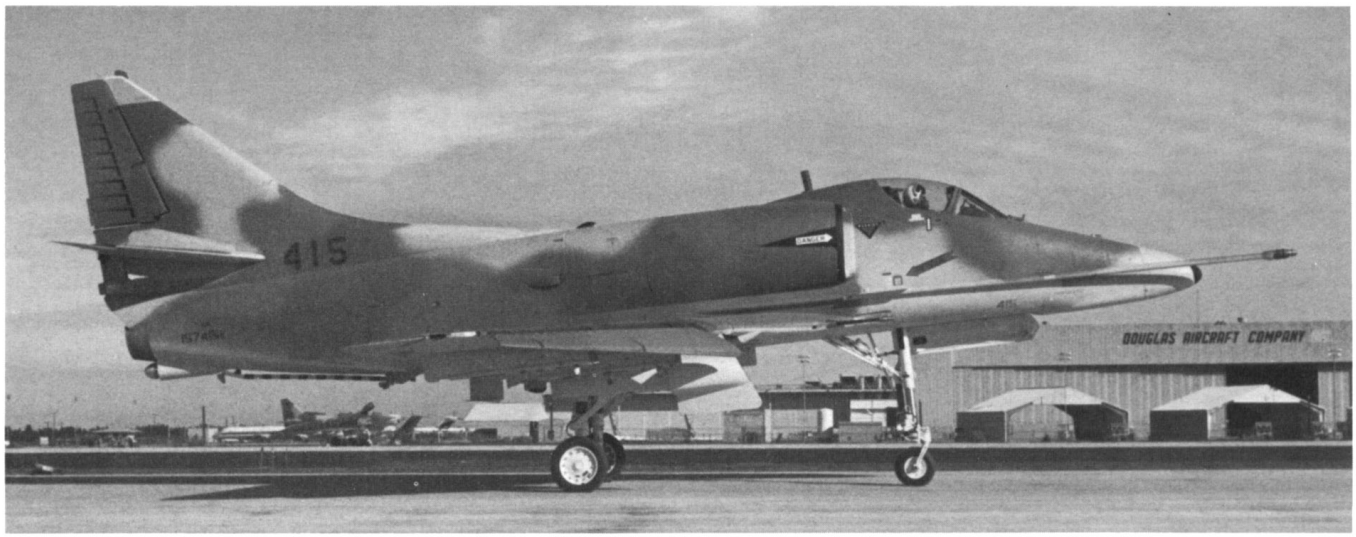
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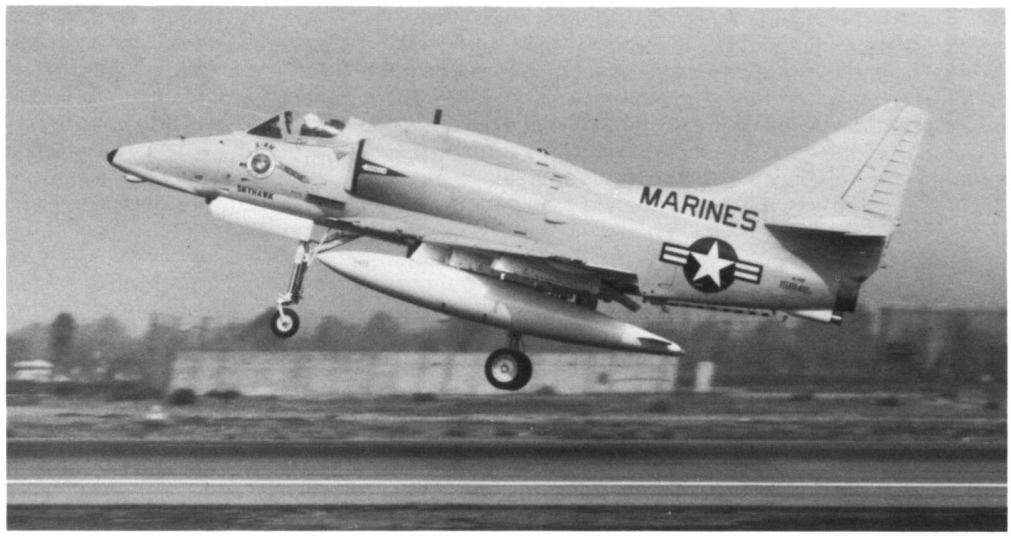


Left above: Lacking any national insignia, an A-4H Skyhawk destined for the Israeli Air Force waits to start its take-off run. New features for this variant included an angular fin top and a braking parachute, the housing for which is visible beneath the tailpipe, whilst 30mm DEFA wing cannon replaced the 20mm weapons of the US Skyhawks. *McDonnell Douglas*
Right: The first A-4M Skyhawk, BuNo 158148, its significance suitably advertised on the nose, beneath the windshield. *McDonnell Douglas*

better take-off characteristics (a 30 per cent cut in roll distance), climb rate and manoeuvrability, and an increase in maximum straight-line speed to around 600kts at sea level; in addition, tell-tale smoke trails vanished thanks to new burner cans.

Appearance changes, though still restrained, were more obvious than in previous upgrade programmes. Israeli experience with the A-4H confirmed the benefits of a braking parachute, and new communications equipment called for a recontoured fin top; at the other end of the fuselage, a bigger canopy and a redesigned windscreen allowed the pilot to see more of the outside world and a state-of-the-art head-up display (HUD) to be installed above the instrument panel, whilst the refuelling boom had a double bend put into it (like A-4E retrofits and late-model A-4Fs), which stopped leaked fuel being carried straight into the starboard engine intake by the airstream, got rid of an interference problem with ECM equipment fitted in the nose and incidentally reduced the overall length of the aircraft. Inside the fuselage the alterations were more far-reaching, with new avionics, extra generating capacity and more ammunition for the 20mm wing cannon.

Still more things have been added to the A-4M since it first entered service in April 1971, most noticeably radar warning receiver (RWR) equipment in a fin-top fairing and electronic countermeasures (ECM) gear in 'blisters' around the nose and tailpipe. An important retrofit programme has seen many A-4Ms fitted with the Hughes Angle Rate Bombing System (ARBS), a laser/TV electro-optical tracker similar to that installed in the AV-8B.

Even the A-4M did not complete the Skyhawk story. Some Israeli A-4Es, originally taken from USN stocks to replace A-4Hs lost during the 1973 Arab-Israeli War, were transferred to Indonesia along with a couple of TA-4Hs; Singapore has been a customer for reconditioned A-4Bs, designated A-4S or, with a second cockpit added, TA-4S; Kuwait has taken delivery of single- and dual-seaters based on the A-4M (A-4KU/TA-4KU); and Israel has received more than 100 A-4Ns, broadly similar to the USMC A-4M. Finally, the Marines themselves have also been issued with two-seat OA-4M forward air control aircraft, converted from TA-4Fs left over from the TA-4J modification programme. Skyhawk refurbishment and evaluation continues to this day, most particularly in Singapore, where SAI is studying the prospects for A-4s fitted with General Electric F404 turbofans. It's true what they say – you just can't keep a good aircraft down!

Left below: A close-in view of the first production A-4M shows some of the appearance changes over earlier aircraft, in particular the redesigned refuelling boom, the rectangular windscreen and the enlarged canopy. The small fairing beneath the nose reportedly housed ECM equipment. *McDonnell Douglas*
Right: The export equivalent of the A-4M was the A-4N, dubbed 'Skyhawk II' by the manufacturers for publicity purposes. Israel bought 117 examples of this variant, and later fitted some of them with an extended tailpipe in an effort to fox heat-seeking missiles. The A-4N has its cannon mounted beneath the wing roots instead of through them. *McDonnell Douglas*

STRUCTURE

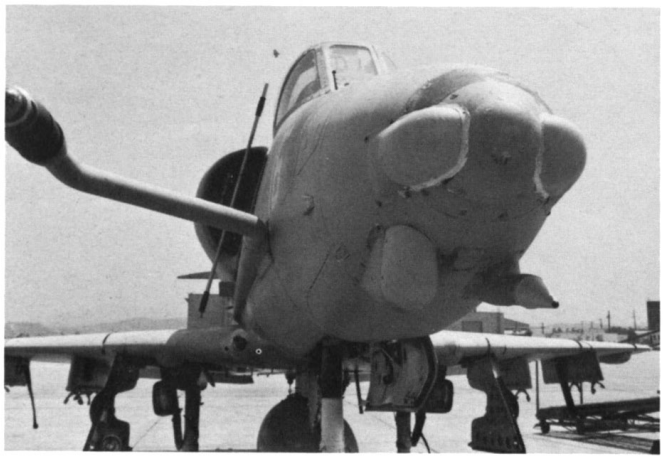
Hand in hand with the light weight of the Skyhawk goes simplicity of structure and great toughness. The bulk of the airframe is in fact made up from only three sub-assemblies – forward fuselage, rear fuselage and one-piece wing. Engine removal requires the separation of the rear fuselage at the simple transport joint roughly half way along; the forward fuselage has the avionics up front, then the cockpit, and then a fuel tank containing 200 gallons (240 US gallons). The layout could hardly be more straightforward. Twin intakes are located either side of the fuel tank. On the A-4M the inlets stand slightly proud of the main fuselage surface, separated from the latter by truncated splitter plates to ensure that an undisturbed flow of air moves through the short ducts to the engine compressor face; on early marks of Skyhawk the inlets were flush against the fuselage. Twin airbrakes, hydraulically operated, are located low down on either side of the rear fuselage.

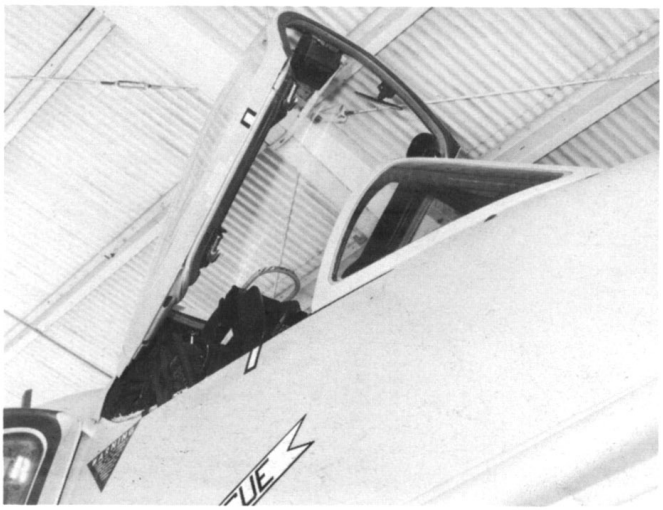
The wing is conventional in its rib and stringer construction, but more unusual is the fact that its three spars are single components, the centre and rear members parallel to each other and the front one bent outboard of the main undercarriage position to follow the sweepback of the leading edge. Forward of the front spar, inboard, are the wing cannon and their ejection chutes, plus the wheel bays (incorporating retractable catapult hooks); outboard are leading-edge slats extending almost to the tips. Behind the rear spar are split flaps inboard and horn-balanced ailerons outboard. In the space between the front and rear spars, right across the wing, are 466 gallons (560 US gallons) of fuel. The upper surfaces of the wing are covered in access panels (there are none to speak of on the undersides), and towards the tips are two rows of vortex generators, the front row mounted along the trailing edge of the slats. These, and the so-called 'sugar scoop' above the tailpipe, were added at an early stage in the Skyhawk development programme to cure buffeting problems. The all-moving horizontal stabilisers are set low on the fin and have traditional horn-balanced elevators.

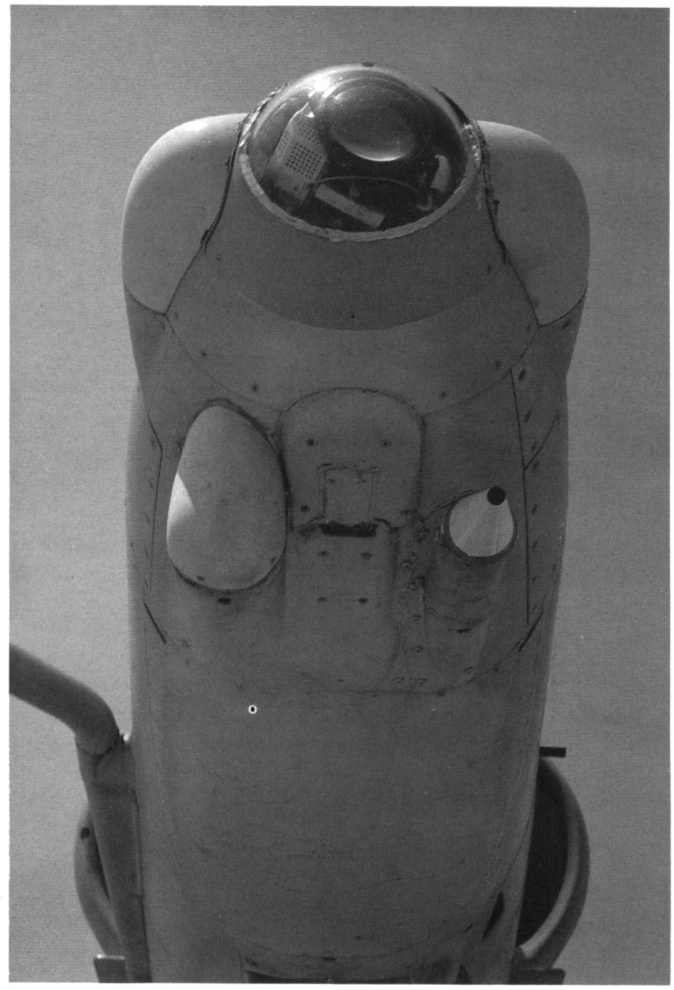
The simplicity of the structure, the elimination of unnecessary joints and the absence of any complex engineering gimmicks mean that the Skyhawk is relatively easy to maintain and, in the case of battle damage, to repair. The aircraft is considered to be, in today's jargon, 'survivable'. Tales of A-4s returning to US aircraft carriers during the Vietnam War riddled with shell holes, with control surfaces shot away and with other seemingly vital pieces missing are legion. In hostile skies over both Vietnam and the Middle East the aircraft has even taken direct hits from air-to-air and air-to-ground missiles and still managed to land safely back at base. With the A-4M's battery of electronic warfare equipment, stowed in the fuselage hump and elsewhere, the Skyhawk now adds cunning to its ruggedness, making it even more of a headache to the enemy.

Below: Another view of 158148 shows some of the salient features of the Skyhawk design: slender, tapered nose; high-set intakes; avionics hump characteristic of later marks; angular fin; and stalky undercarriage gear. *McDonnell Douglas*
Right: Top surface of an A-4M nose, ECM blisters prominent at the tip. The fairing at the base of the windscreen is a duct for blasting rain off the glazing; Skyhawk versions up to the A-4C had wiper arms.


15







Opposite page top: Starboard nose detail of an A-4M assigned to VMAT-102, the Marines' Skyhawk training squadron based at MCAS Yuma. *Harry Gann/McDonnell Douglas*

Opposite page centre left: ECM/ESM recording/suppression antenna 'blisters' on the nose of an A-4M. The conical housing on the port lower contours is mirrored by a similar fitting at the base of the rudder.

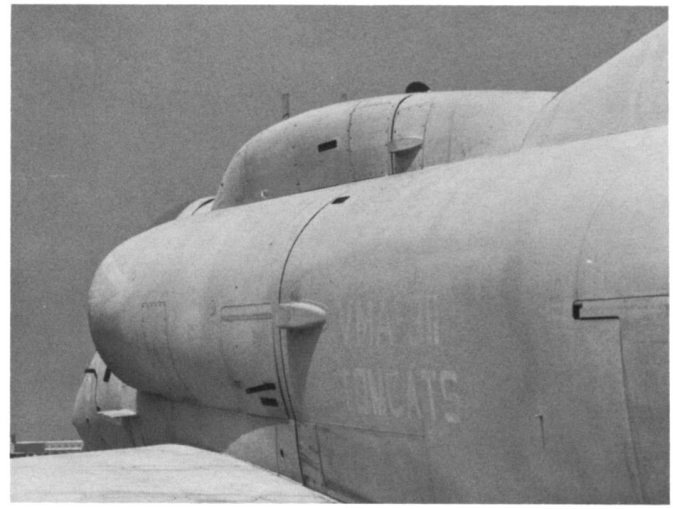
Opposite page bottom left: Windshield and canopy details, early production A-4M. *McDonnell Douglas*

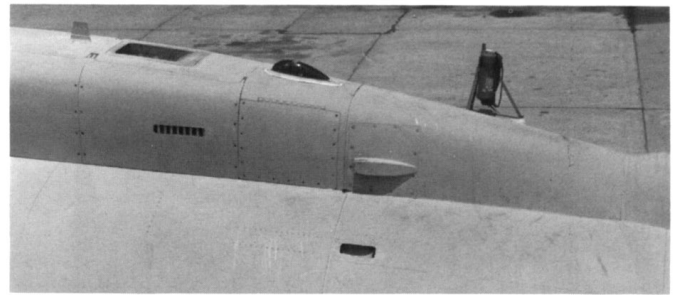
Opposite page bottom right: ARBS (Angle Rate Bombing System) seeker/tracker lens. A-4Ms fitted with this equipment are reportedly designated A-4Y.

This page: Forward fuselage, viewed from the port side. The strakes above the wing cannon prevent gases being ingested into the engine intakes.

Above: The A-4M's intakes stand clear of the fuselage to prevent turbulent air flowing along the fuselage boundary layer from entering them, and the fixed splitter plates (introduced with the A-4E model) also help with this. Angle of attack (AOA) sensor is located beneath the windscreen.
Below left: View along the starboard fuselage side; the airbrake is partially open.
Below right: Two photos showing the dorsal avionics hump characteristic of all late-model Skyhawks.

Opposite page top: Typifying the colourful finishes of US Navy and Marine Corps aircraft during the 1960s and 1970s is this USMC A-4M of VMA-324 ('Vagabonds'), photographed in 1971. VMA-324 was the first operational unit to receive the A-4M. *Harry Gann/McDonnell Douglas*
Opposite page bottom: Just as colourful were the A-4Ms of VMA-331, as this 1976 photo of a 'Bumblebees' aircraft shows. Like 158160, this is an early model A-4M, lacking the fin-top fairing etc. *Harry Gann/McDonnell Douglas*






DX
MARINES
A-4M
158160
VMA-324

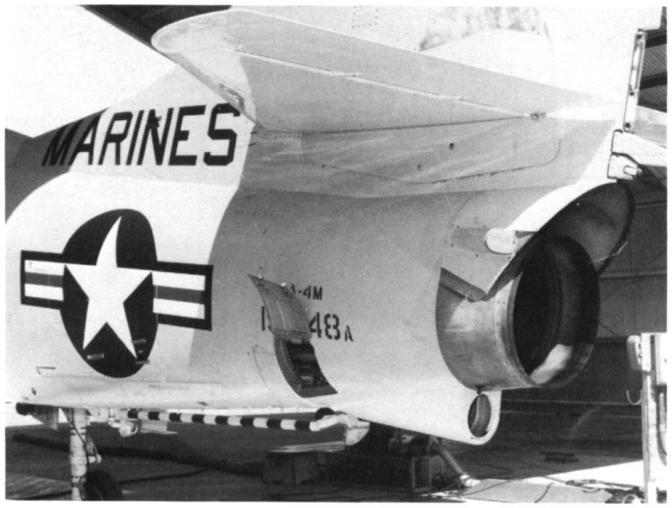

10
VL
8185
MARINES
VMA-331
10
158185

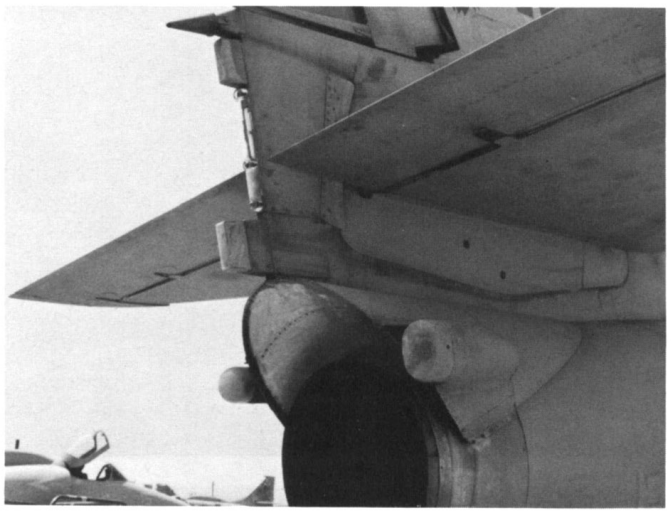

WL
07
VMA-311
TOMCATS
MARINES

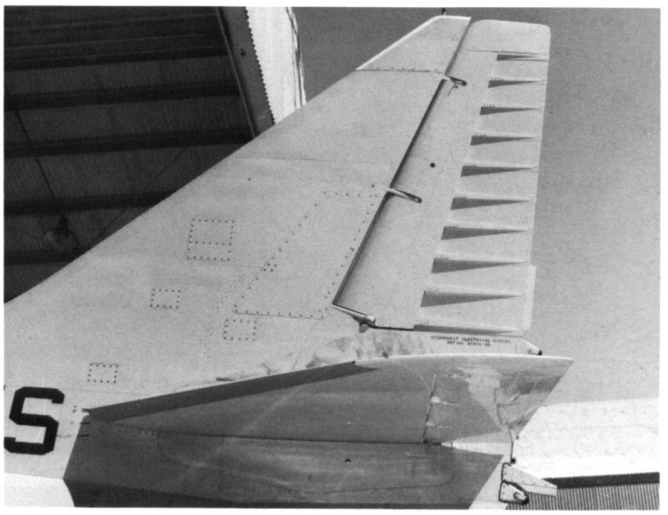

WL
VMA-311
TOMCATS
MARINES

Opposite page: Two views of A-4M 160024, VMA-311 ('Tomcats'), photographed at MCAS El Toro, spring 1985. Finish is low-contrast greys (see page 32), although nose number, squadron designation and fin decor detail on this particular machine are white. In typical ground pose, flaps, slats and arrester hook are lowered. This Skyhawk is fitted with ARBS.
Above: Undersurface and nosegear details of the same aircraft. Notice that the undercarriage doors are edged in red, and that the nosewheel leg is lashed down.
Below: A 'Tomcats' A-4M in interim scheme: compared with the earlier, 1970s scheme shown on the back cover of this book, the red and yellow decor has gone. The photo was taken in 1985.
Bottom: Another interim scheme on a VMA-311 A-4M, with standard-size (though low-contrast) national insignia and diminutive fin emblem and letters, 1978. *Harry Gann/McDonnell Douglas*

Above: Another variation on the all-grey tactical scheme, employing, apparently, Light Gray, Light Ghost Gray and Dark Ghost Gray, seen applied to an A-4M of VMA-214 ('Blacksheep'). The companion Skyhawk carries the original scheme. *Harry Gann/McDonnell Douglas*
Below: The last Skyhawk, 160264, suitably emblazoned with the flags of all the A-4 user nations. The handover ceremony for this aircraft, an A-4M, was conducted on 27 February 1979. *McDonnell Douglas*
Opposite page top left: Rear fuselage and jetpipe, early A-4M. Brake parachute is not yet installed. *McDonnell Douglas*
Opposite page top right: A similar angle on a later aircraft, showing changes in the shape of the antenna domes etc.
Opposite page centre left: Starboard view of tailpipe area; note that the ECM domes on the 'sugar scoop' are of different sizes.
Opposite page centre right: Early A-4M fin, showing ribbed rudder and absence of tip fairing. *McDonnell Douglas*
Opposite page bottom: Two views showing current fin details. Note scuffing caused by tailplane movement.


MARINES

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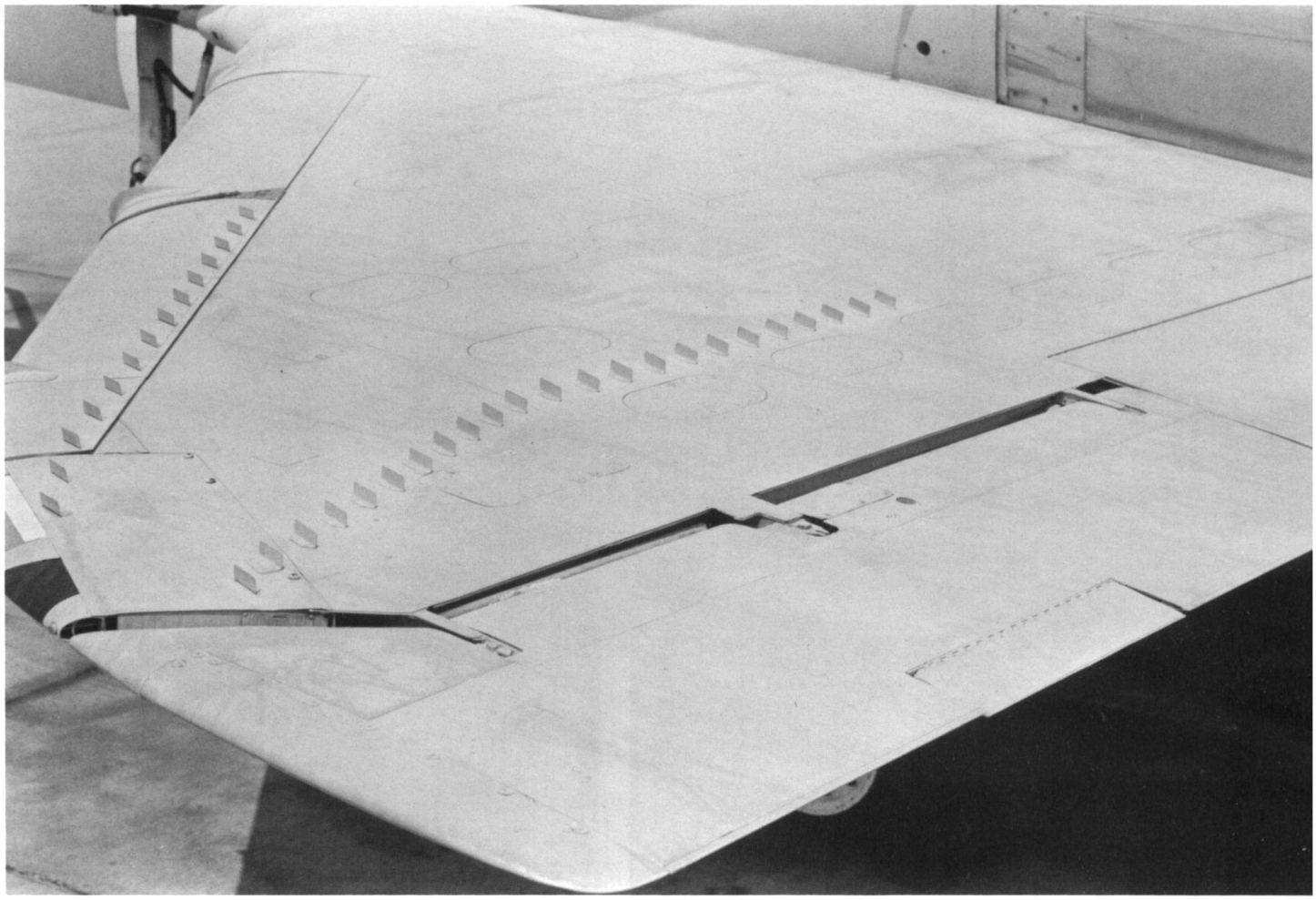
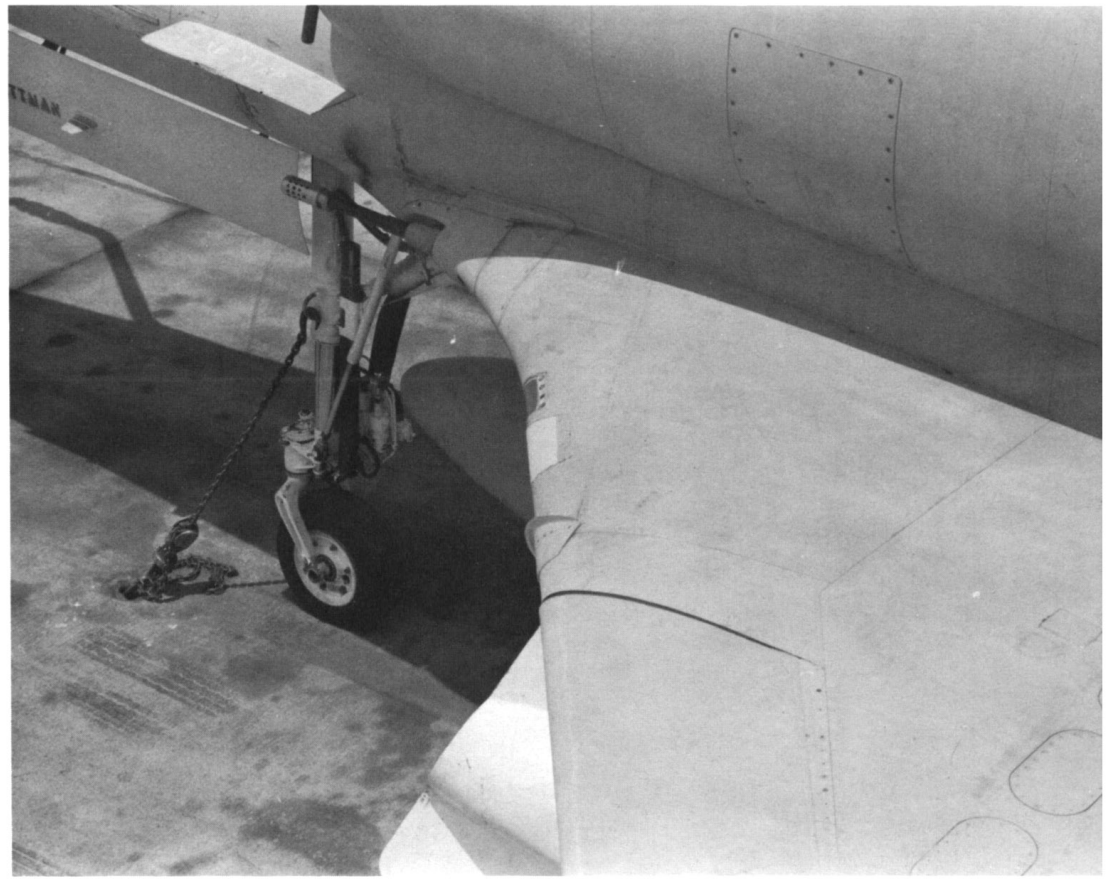
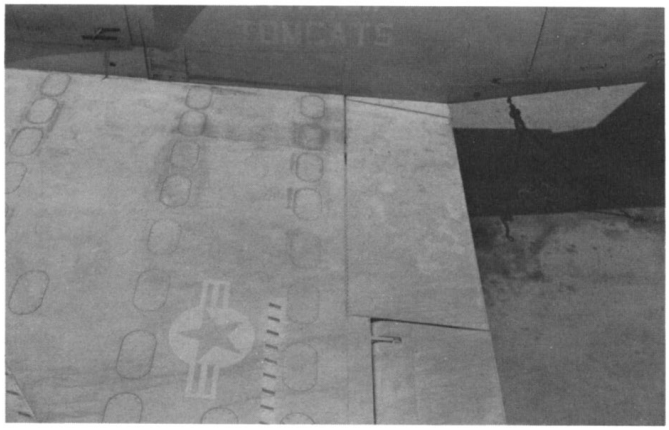
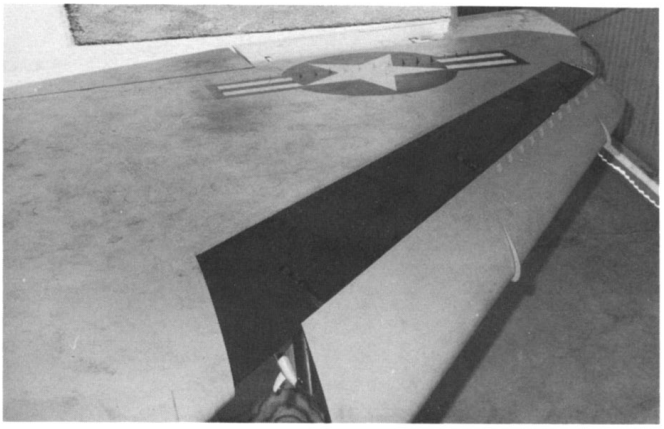
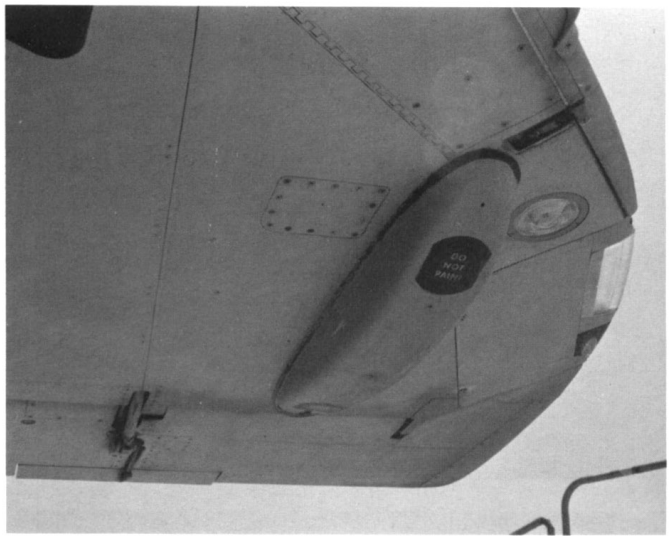




Above: View over port wing, showing horn-balanced aileron with trim tab and double row of vortex generators.
Right: Port wing root. A small wing fence is fitted at the leading edge, with, beyond, the unpainted cover for the marker beacon antenna and the clear cover over the carrier approach lights.
Opposite page top left: Inboard of the aileron is a split spoiler/flap. Upper wing surface is liberally sprinkled with access panels.
Opposite page top right: Leading-edge slat, shown deployed. Inner surfaces, here red, are generally painted the same colour as the wing on all-grey Skyhawks. *McDonnell Douglas*
Opposite page centre: Two photos of the undersides of the port wing tip; the radar altimeter antenna fairing is a very recent A-4M retrofit.
Opposite page bottom: Low-angle view showing slat actuator guide rails.


TOMCATS

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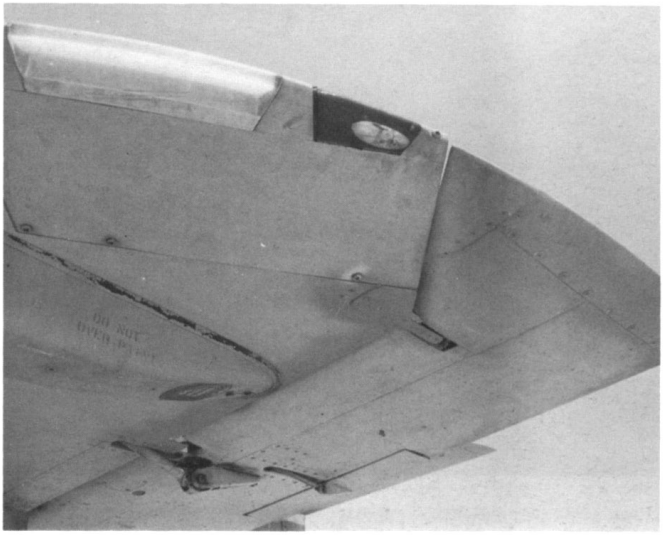
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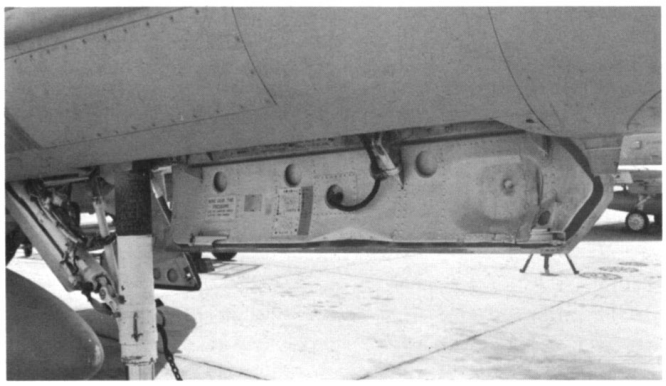
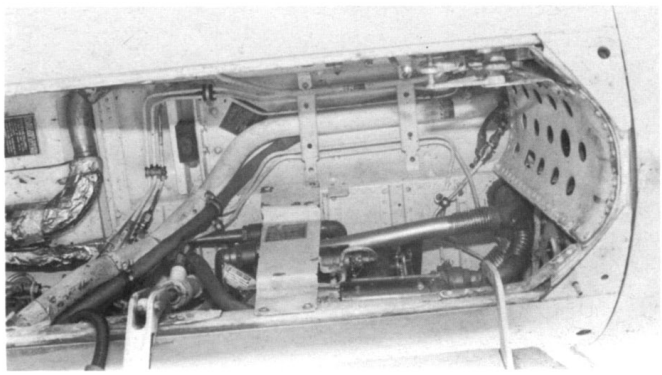
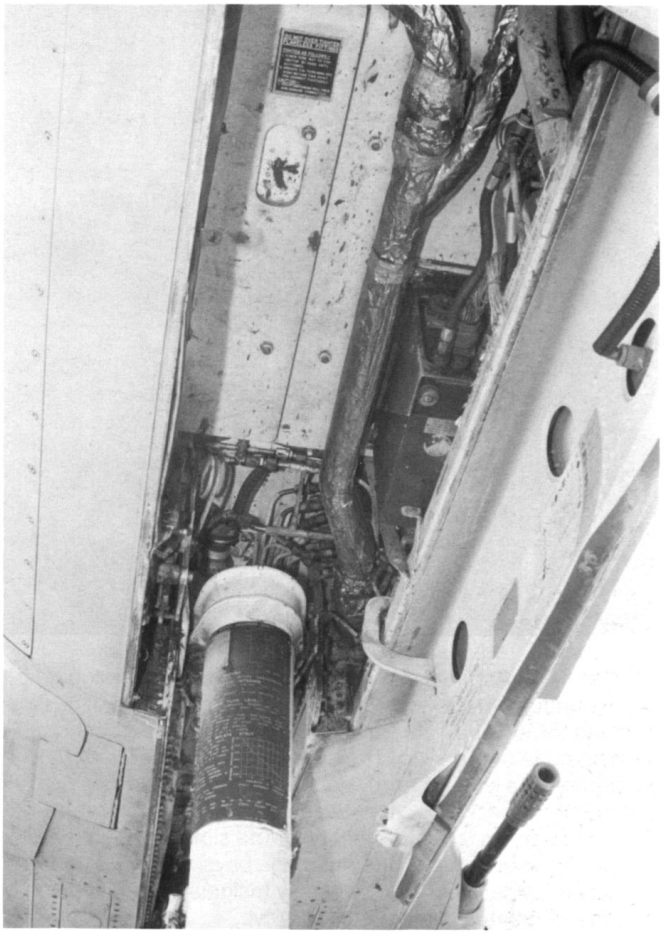
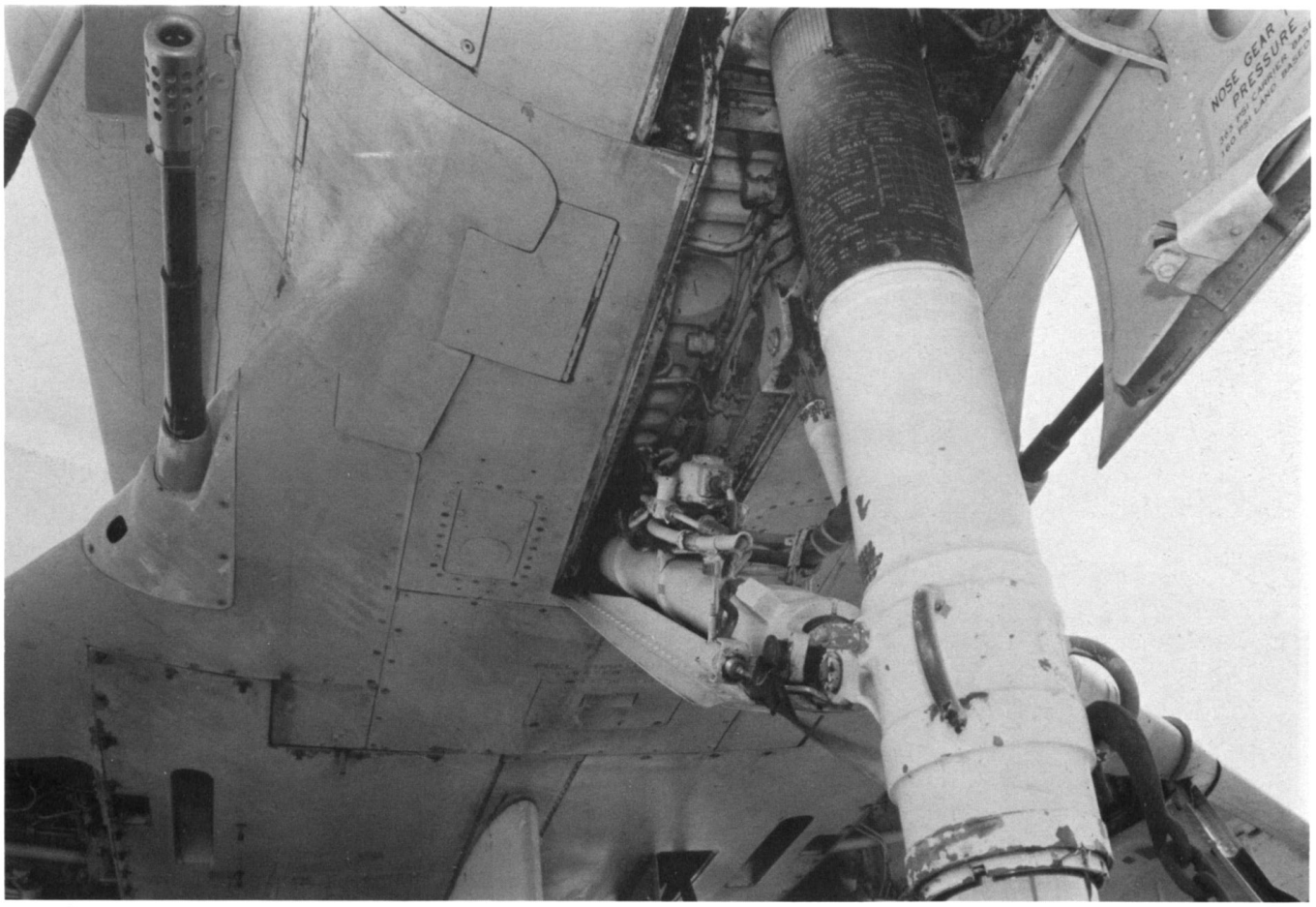
DO NOT OVER PAINT
DO NOT OVER PAINT

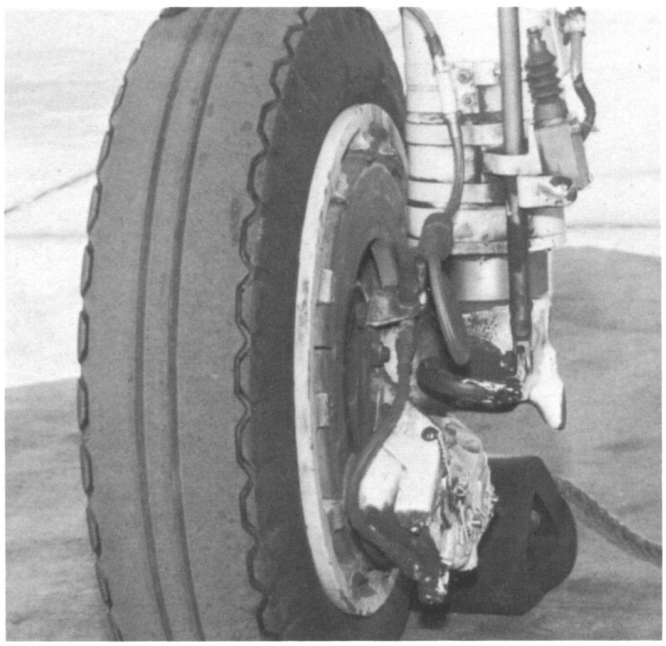
This spread: Aspects of the A-4M Skyhawk's nose gear. The stalky appearance of the A-4's undercarriage is emphasised by the unusually long oleo stroke of the nose leg, which also gives a slightly nose-up ground attitude to the aircraft. The nose wheel was non-steerable on early versions, but the A-4F and subsequent variants were fitted with steering units, the cables for which can be seen running down the back of the leg to the unit on the yoke. This modification apparently gave some trouble, and some aircraft had their equipment removed. Note advisory panels on inside of forward gear door.

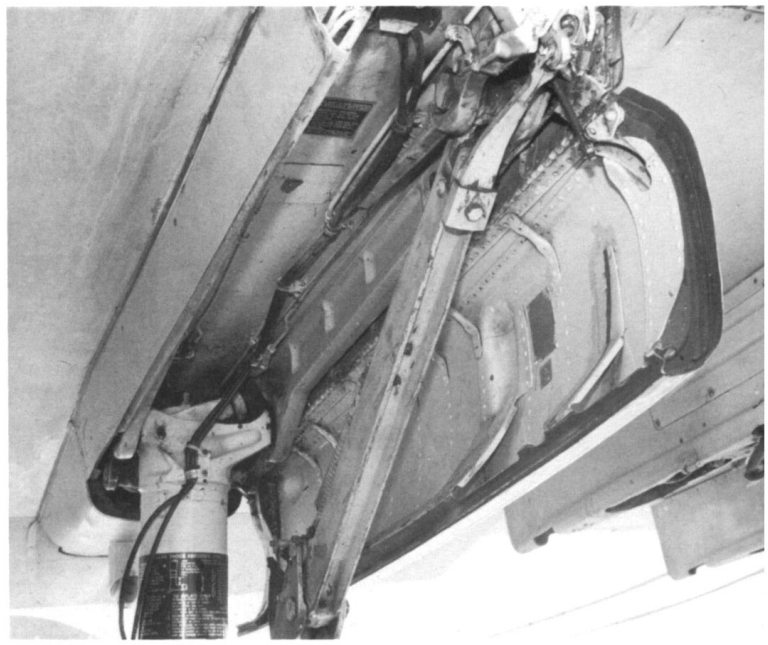




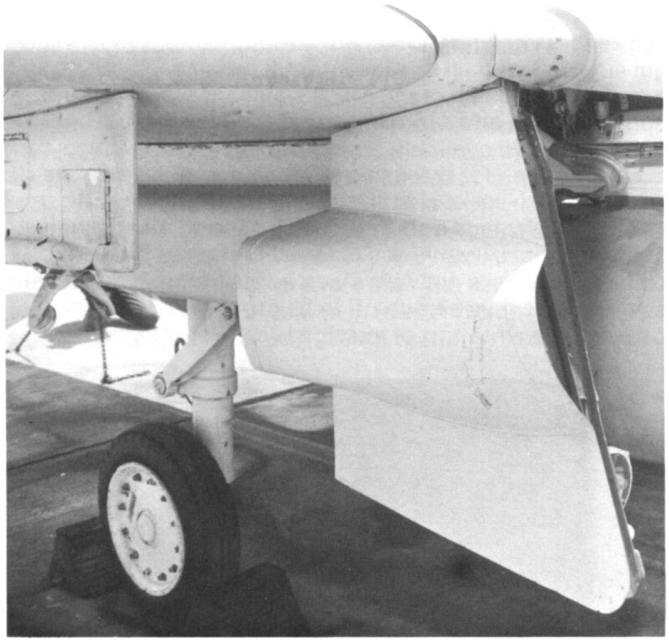


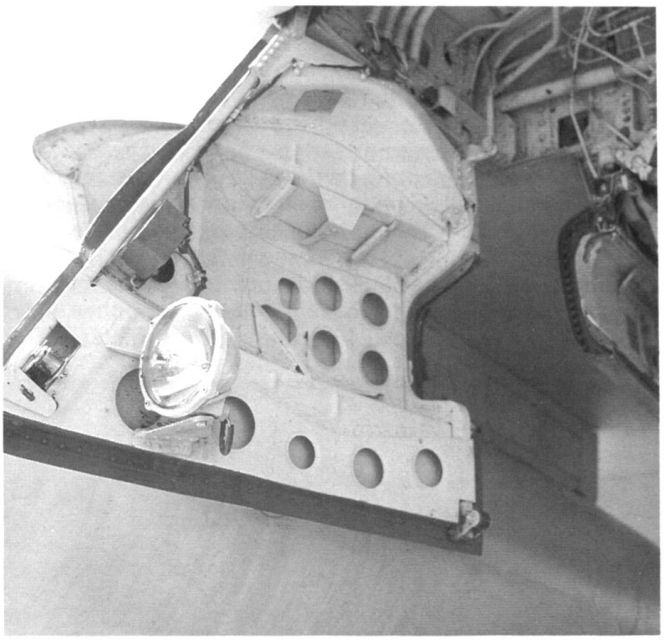

NOSE GEAR
PRESSURE





This spread: Aspects of the A-4M's main undercarriage gear. All the undercarriage legs retract forwards, the main units also rotating through 90 degrees to lie in shallow wells towards the leading edge of the wing. The starboard main gear door incorporates a landing lamp; notice also the retractable catapult hold-back hook (painted yellow) in the photograph opposite bottom, and the ejection chute slots for spent cannon ammunition. All undercarriage bays, gear legs and hubs and insides of doors are glossy Insignia White, even on Skyhawks painted in low-visibility greys.



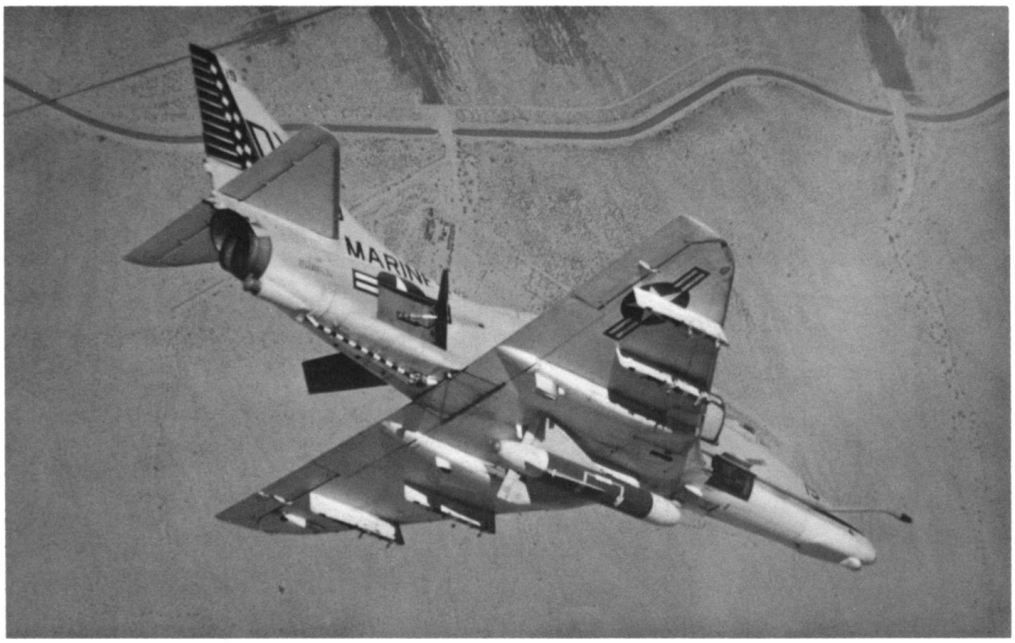



EXTERNAL
DUCTS

MISSION

Just as the structure and appearance of the Skyhawk are more or less unchanged since the aircraft's inception thirty-five years ago, so also the job it has to do is not that much different. It can now carry more weapons than it used to and plant them more accurately and surely, and the commander now has a much wider choice of ordnance to hang on the pylons, but the single-seat Skyhawk is still flown for one reason – close air support. It is and always has been essentially a single-mission aeroplane.

The A-4M version has five stores points beneath the wing, two each port and starboard and one centreline. Maximum capacities are 2240lb inboard wing, 570lb outboard wing (1000lb some aircraft) and 3575lb centreline, totalling 9195lb, but although the Skyhawk can get airborne with all this the internal fuel capacity is penalised: 12,220lb of the gross weight is available for fuel and ordnance, and a maximum warload leaves just over 3000lb (2000lb) available for internal fuel, but the tanks can hold getting on for twice this amount. In other words, in common with strike aircraft the world over, the A-4M can carry a lot of things a short distance or somewhat fewer a longer distance (with three external fuel tanks fitted, of course, it can take not very much a considerable distance), so there is always a trade-off to be organised, depending on precisely what sort of mission is called for (*ie* nature of



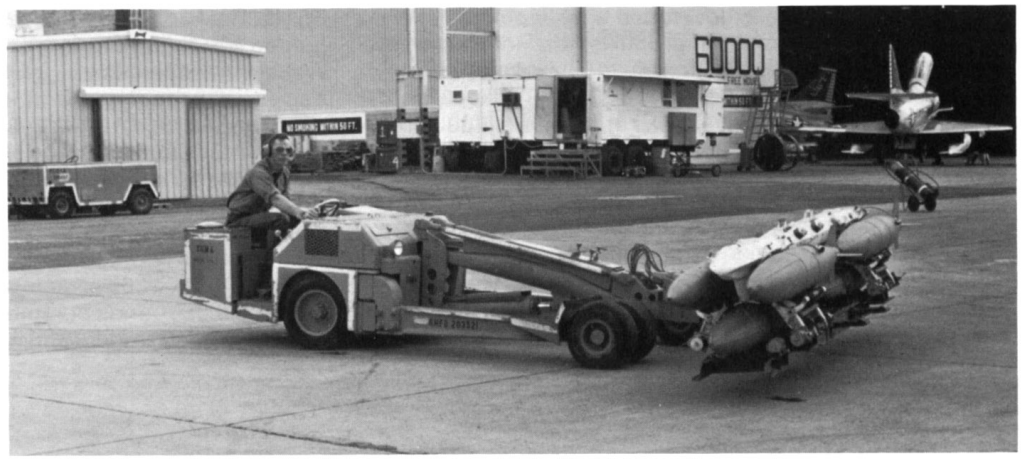
Left: Air brakes fully open, an A-4M Skyhawk from VMA-324 dives towards the desert floor with an AGM-62 Wall-eye mounted on its centre-line. *Harry Gann/McDonnell Douglas*
Below: Unfused, low-drag, 'dumb' bombs posed in front of a 'Vagabonds' A-4M. The Skyhawk at the far right is carrying what appears to be a napalm canister. *McDonnell Douglas*
Right: Another VMA-324 A-4M, this one letting go a 5in folding-fin Zuni rocket. *Harry Gann/McDonnell Douglas*
Right below: One of VMA-214's A-4Ms, armed with Snakeye retarded bombs and a 330-gallon (400 US gallon) tank. *Harry Gann/McDonnell Douglas*

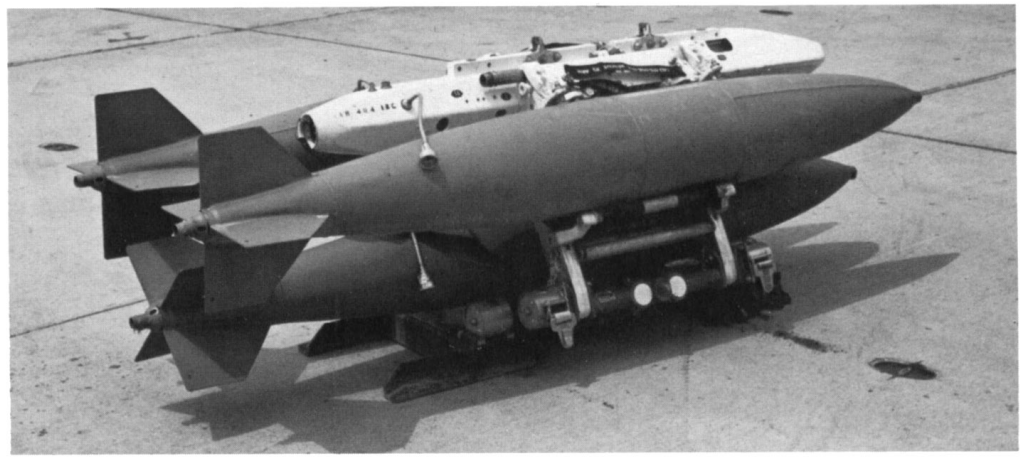
target, how far away it is, how much time should be spent over it, and what sort of flight profile is needed to reach it).

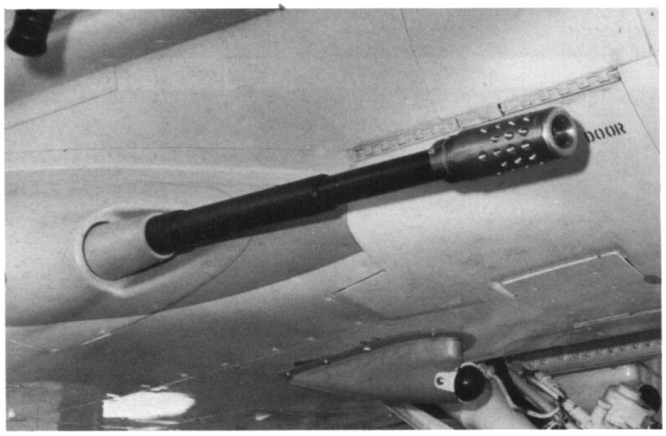
As with other US military aircraft, the A-4M carries its ordnance on Aero-series ejector racks, which, like a good percentage of US 'dumb' weapons and external fuel tanks, were developed by Douglas themselves during the early 1950s in response to the need to eliminate, or at least lessen, the drag induced by World War II-type stores, Virtually the full range of weapons on the USMC inventory can be fitted, recent years seeing such 'smart' ordnance as the Maverick missile cleared for use. The official external weapons listing gives options of fourteen 500lb bombs, three 1000lb bombs or one 2000lb bomb; or four AGM-45 Shrike anti-radar missiles; or four AGM-65C/E laser-guided Maverick missiles; or three TV-guided AGM-62 Walleye missiles; or a single Mk 28, Mk 43 or Mk 57 nuclear weapon. Not mentioned now is the command-guided ASM-N-7 (AGM-12) Bullpup, for years synonymous with A-4 precision attacks. One important non-offensive store frequently carried is a 250-gallon (300 US gallon) 'buddy' refuelling pack, again originally designed by Douglas.

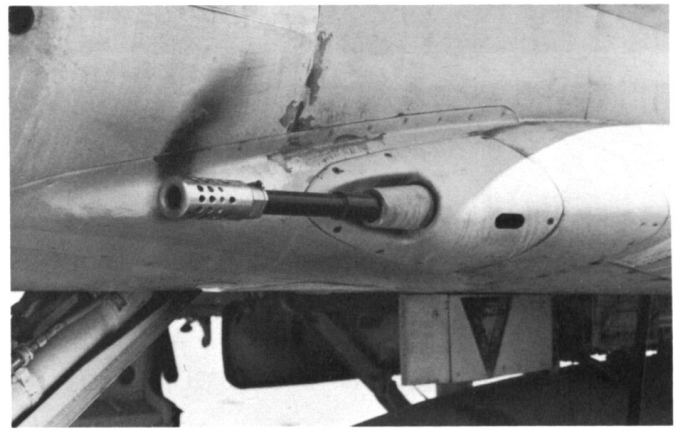
The A-4M's two Colt 20mm Mk 12 cannon in the wing roots each have 200 rounds available; rate of fire is of the order of 1000 rounds per minute. These weapons are useful against ground targets and for self defence if required.

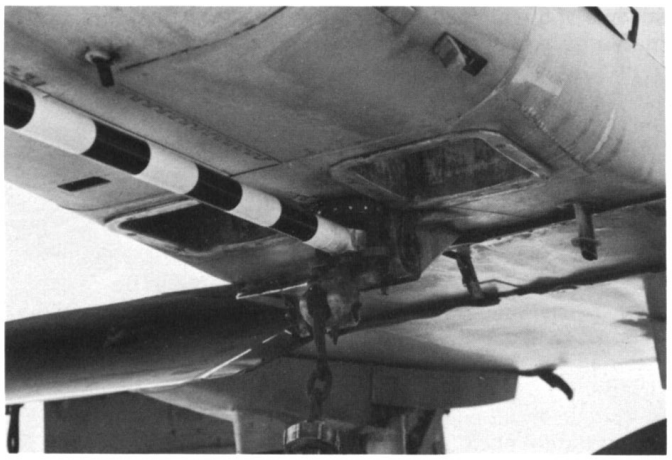
Right above: A fully laden Multiple Ejector Rack (MER) is taken out to the VMAT-102 flight line, Yuma, 1976. *Harry Gann/McDonnell Douglas*
Right below: A Triple Ejector Rack (TER) with canister practice ordnance destined for an A-4M . *Harry Gann/ McDonnell Douglas*
Below left: Starboard Mk 12 cannon installation, early A-4M. *McDonnell Douglas*
Below right: Port wing cannon, the scorch marks evidence of recent use.
Bottom left: Starboard underwing pylons, with access panel open.
Bottom right: A 400 US gallon fuel tank on the centre-line station.
Opposite page top left: Rear aspect of 400 US gallon tank (upper photo) and arrester hook attachment, flanked by chaff chutes (lower).
Opposite page top right: Escapac 1C-3 ejection seat as installed in an A-4M. *McDonnell Douglas*
Opposite page bottom: A-4M Skyhawk main instrument panel. *McDonnell Douglas*

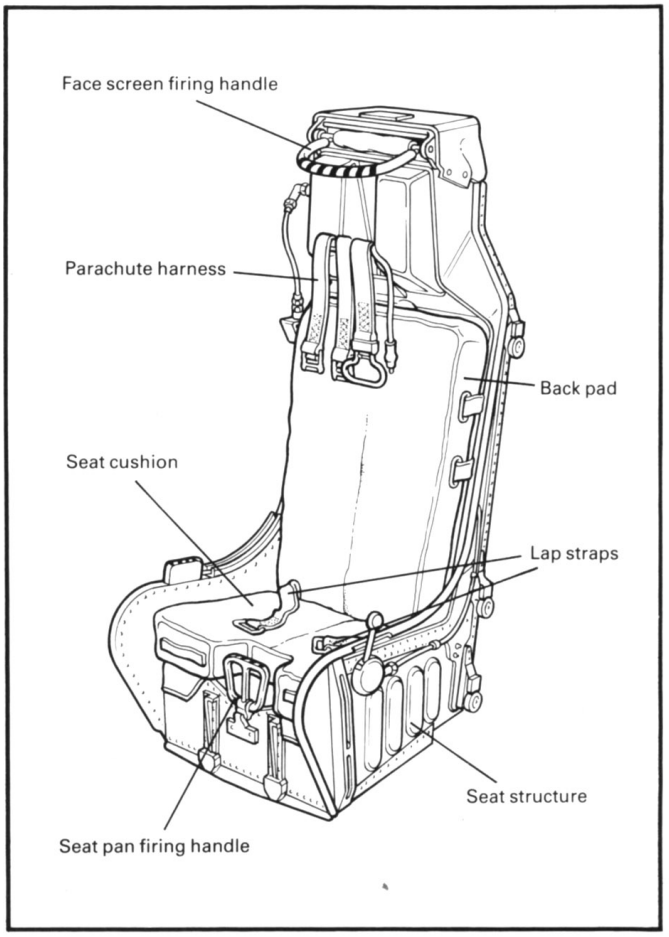


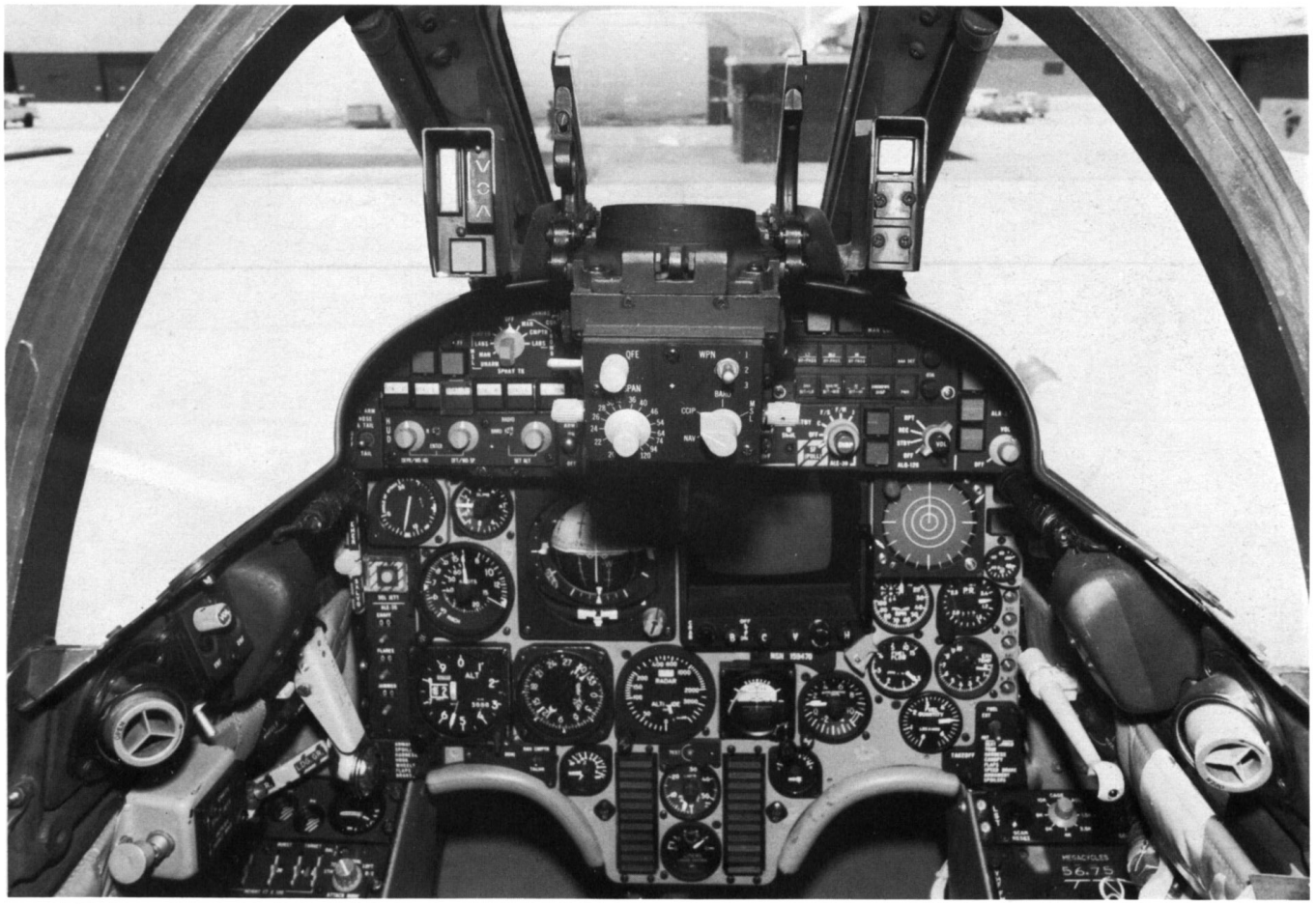









Face screen firing handle
Parachute harness
Back pad
Seat cushion
Lap straps
Seat structure
Seat pan firing handle



SQUADRON SERVICE

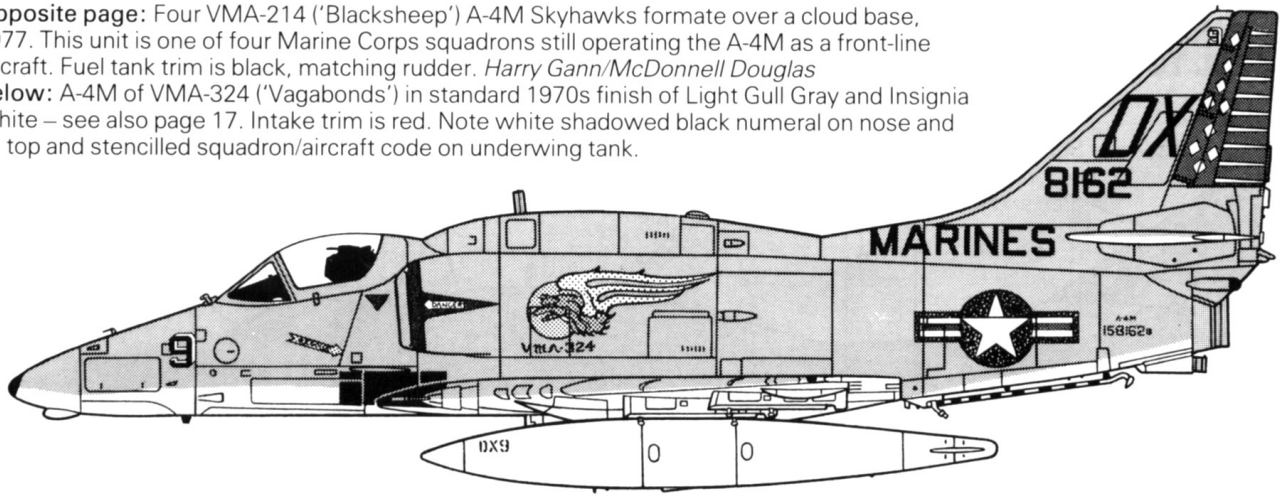
The ceremony described in the opening paragraph on page 4 of this book marked the delivery to the US Marine Corps of the 2690th and last Skyhawk to be built. Its special paint scheme did not last for long, and it quickly reverted to anonymity along with the other A-4Ms on the flight lines at Cherry Point. Its squadron, VMA-331 (tail code 'VL') has now disbanded and the aircraft have been dispersed elsewhere; this particular machine went to the Naval Air Test Center at Patuxent River, Maryland.

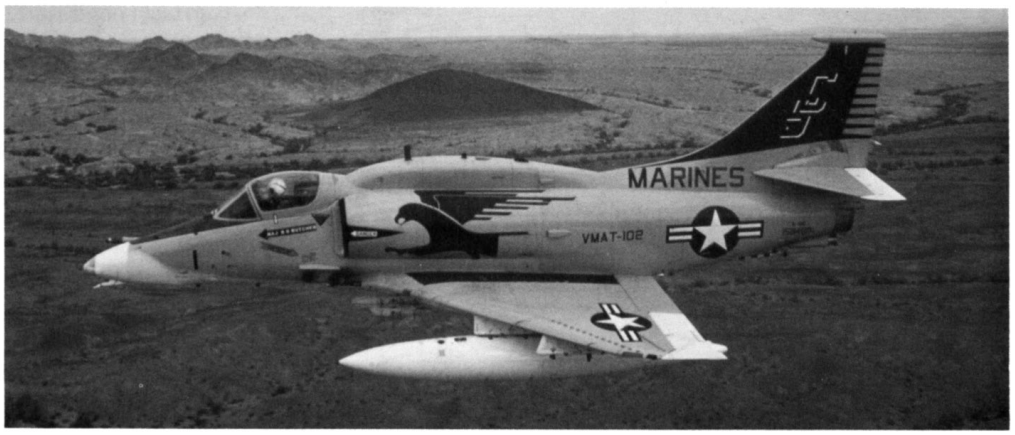
Four front-line Marine Corps attack squadrons now operate the A-4M, VMA-211 (tail code 'CF'), VMA-214 ('WE'), VMA-223 ('WP') and VMA-311 ('WL'). These units are deployed, by a process of rotation, at MCAS El Toro, California (3rd Marine Aircraft Wing), MCAS Cherry Point (2nd MAW) and MCAS Iwakuni, Japan; the 3rd MAW is assigned to Fleet Marine Force Pacific (FMFPAC) and the 2nd MAW to Fleet Marine Force Atlantic (FMFLANT). Squadron strength is typically nineteen aircraft. Backing up the regular units is the A-4 training squadron, VMAT-102 ('SC'), based at MCAS Yuma, Arizona. This operates A-4Ms along with TA-4H two-seaters. At NAS South Weymouth, Massachusetts, is VMA-322 (4th MAW, 'QR'), the Reserve Force A-4M squadron. The USMC continues to operate the older A-4E/F (now exclusively in Reserve and training units), plus thirty OA-4M FAC Skyhawks. Other A-4M users have been VMA-324 ('DX'), VMAT-203 ('KD') and of course VMA-331. Finally, A-4Ms are also flown by VX-5 ('XE'), the USN Development Squadron based at China Lake, California.

A-4Ms began to equip Marine squadrons in April 1971, when four aircraft arrived at MCAS Beaufort, South Carolina, for VMA-324. They were finished in the standard USN/USMC colour scheme of the time, Light Gull Gray (FS.36440) upper surfaces and fuselage sides and Insignia White (17875) lower surfaces. The top colour was non-specular (*ie* lustreless, or matt) and the lower glossy. National insignia, in four positions, were the standard red (11136), white (17875) and blue (15044) and lettering was black. Individual units applied their own distinctive, full-colour markings, usually mid-way along the fuselage sides and on the tailfin. A low-visibility scheme for Skyhawks was approved for introduction on 25 August 1980 and comprised Gray 36320, Mid Gray 36375 and Light Gray 36495. This began to be applied to A-4s from that date on (see next spread), but other interpretations of the all-grey tactical scheme have appeared, notably one using a combination of greys 36293, 36440 and 36559 (see page 36).

As with all military paint schemes, the instructions for applying the low-visibility colours are quite specific, and although patterns may vary from aircraft to aircraft (after all, different types have different shapes), certain basic principles are adhered to throughout. The main point is that the greys are employed across the entire external surface of the aircraft, including the national insignia, unit markings, warning notices and even stencilled instructions. In the case of a three-grey scheme like that approved for the Skyhawk, the rule of thumb is that the darkest and lightest colours should never touch: if the background paintwork is either 36320 or 36495, the constrasting shade used is 36375; if 36375, the contrasting colour is the darker grey, 36320. Another general rule is that all the national insignia are to be based on a 12in diameter star; a third is that adjacent main airframe colours should be blended, the blended area to be 'approximately 6in wide'; a fourth is that no decals are to be used on any outside surface. There are many anomalies to be found, however, for example the continuing use of Insignia White for some external markings, and it will doubtless be some time yet before the changeover to the new scheme has been completed.

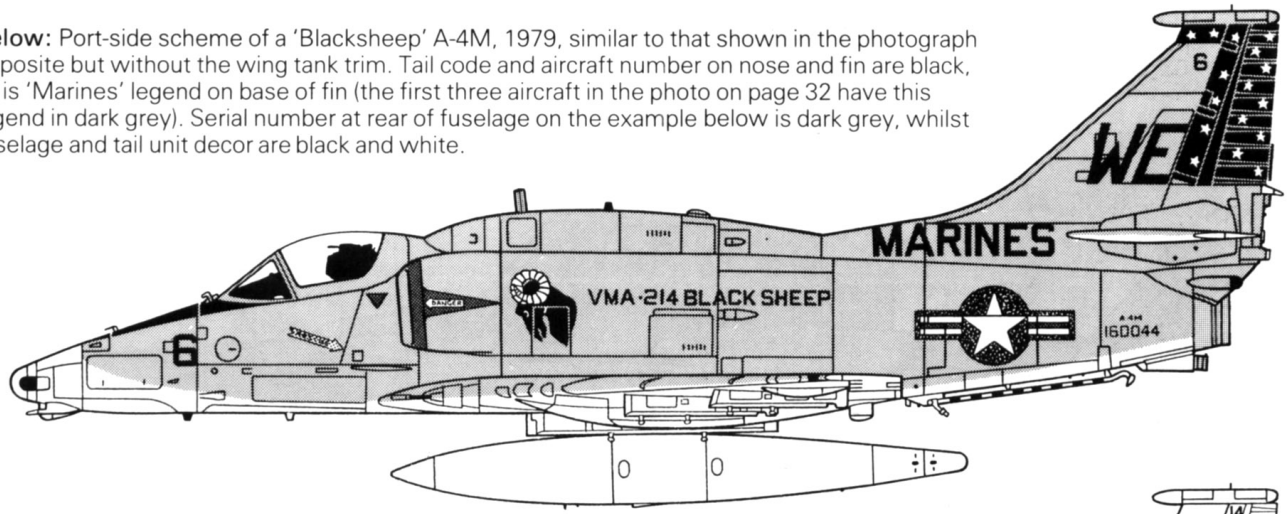
Opposite page: Four VMA-214 ('Blacksheep') A-4M Skyhawks formate over a cloud base, 1977. This unit is one of four Marine Corps squadrons still operating the A-4M as a front-line aircraft. Fuel tank trim is black, matching rudder. *Harry Gann/McDonnell Douglas*
Below: A-4M of VMA-324 ('Vagabonds') in standard 1970s finish of Light Gull Gray and Insignia White – see also page 17. Intake trim is red. Note white shadowed black numeral on nose and fin top and stencilled squadron/aircraft code on underwing tank.



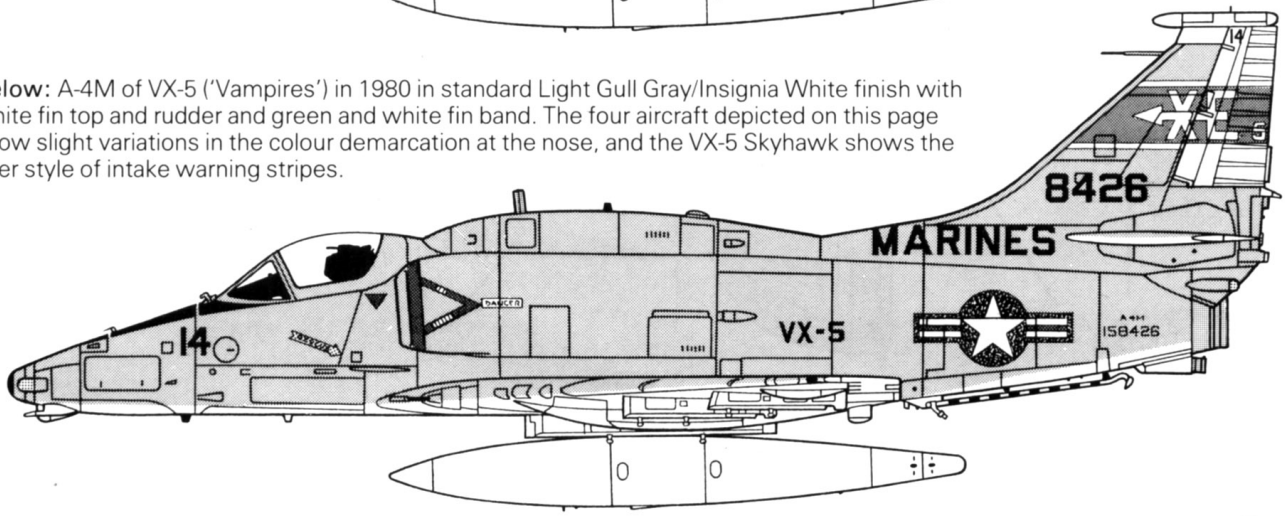


Left: A 1976 photo of an A-4M from VMAT-102, the Yuma-based Marine Skyhawk training squadron. Unit decor on fuselage and tailfin is Insignia Red, which colour also picks out the external framework of the rudder. The interlocking fin code digits are black, with a white 'shadow' effect. Nose cone is white with a buff tip. Overall scheme is Light Gull Gray and Insignia White. *Harry Gann/McDonnell Douglas*

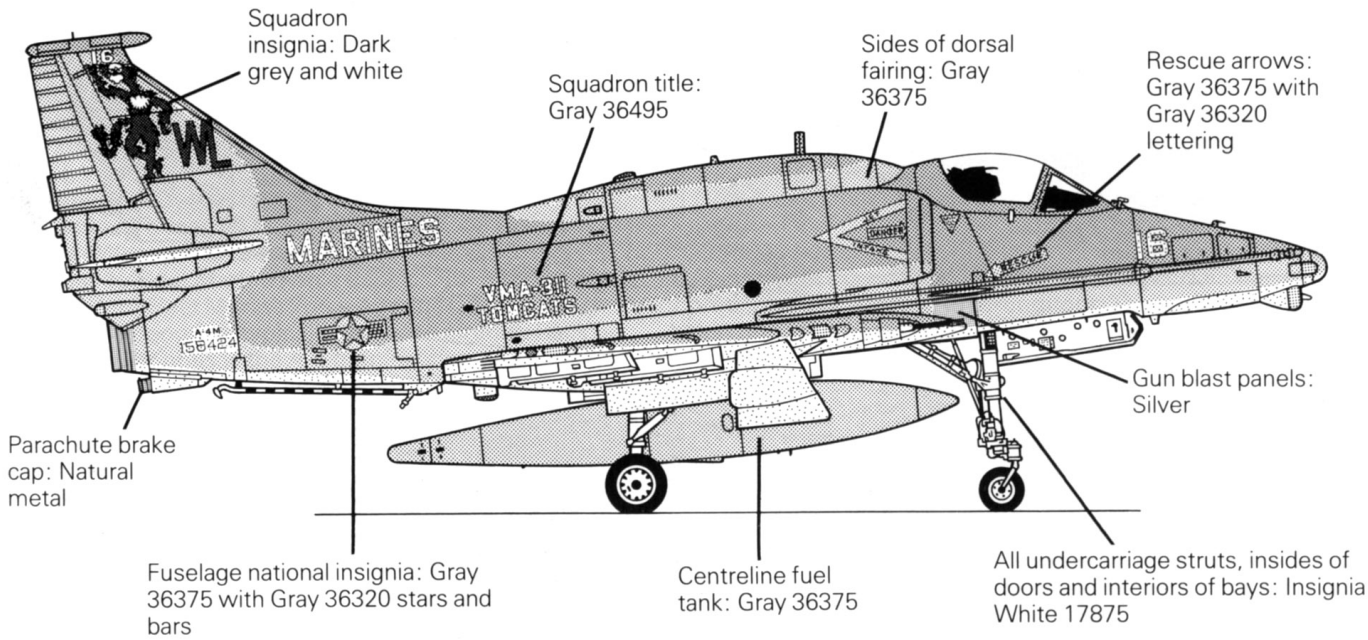
Below: Port-side scheme of a 'Blacksheep' A-4M, 1979, similar to that shown in the photograph opposite but without the wing tank trim. Tail code and aircraft number on nose and fin are black, as is 'Marines' legend on base of fin (the first three aircraft in the photo on page 32 have this legend in dark grey). Serial number at rear of fuselage on the example below is dark grey, whilst fuselage and tail unit decor are black and white.

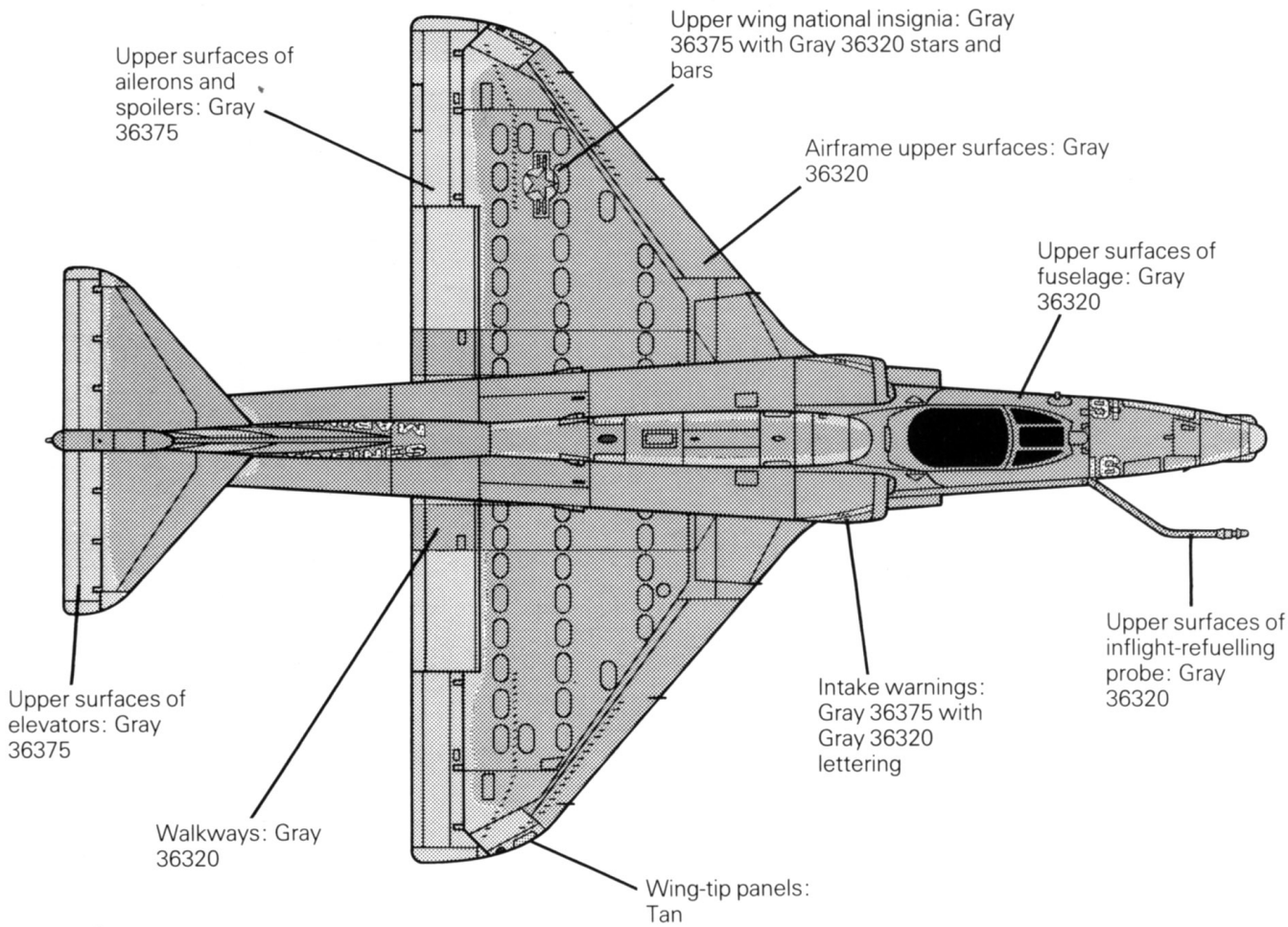


Below: A-4M of VX-5 ('Vampires') in 1980 in standard Light Gull Gray/Insignia White finish with white fin top and rudder and green and white fin band. The four aircraft depicted on this page show slight variations in the colour demarcation at the nose, and the VX-5 Skyhawk shows the later style of intake warning stripes.

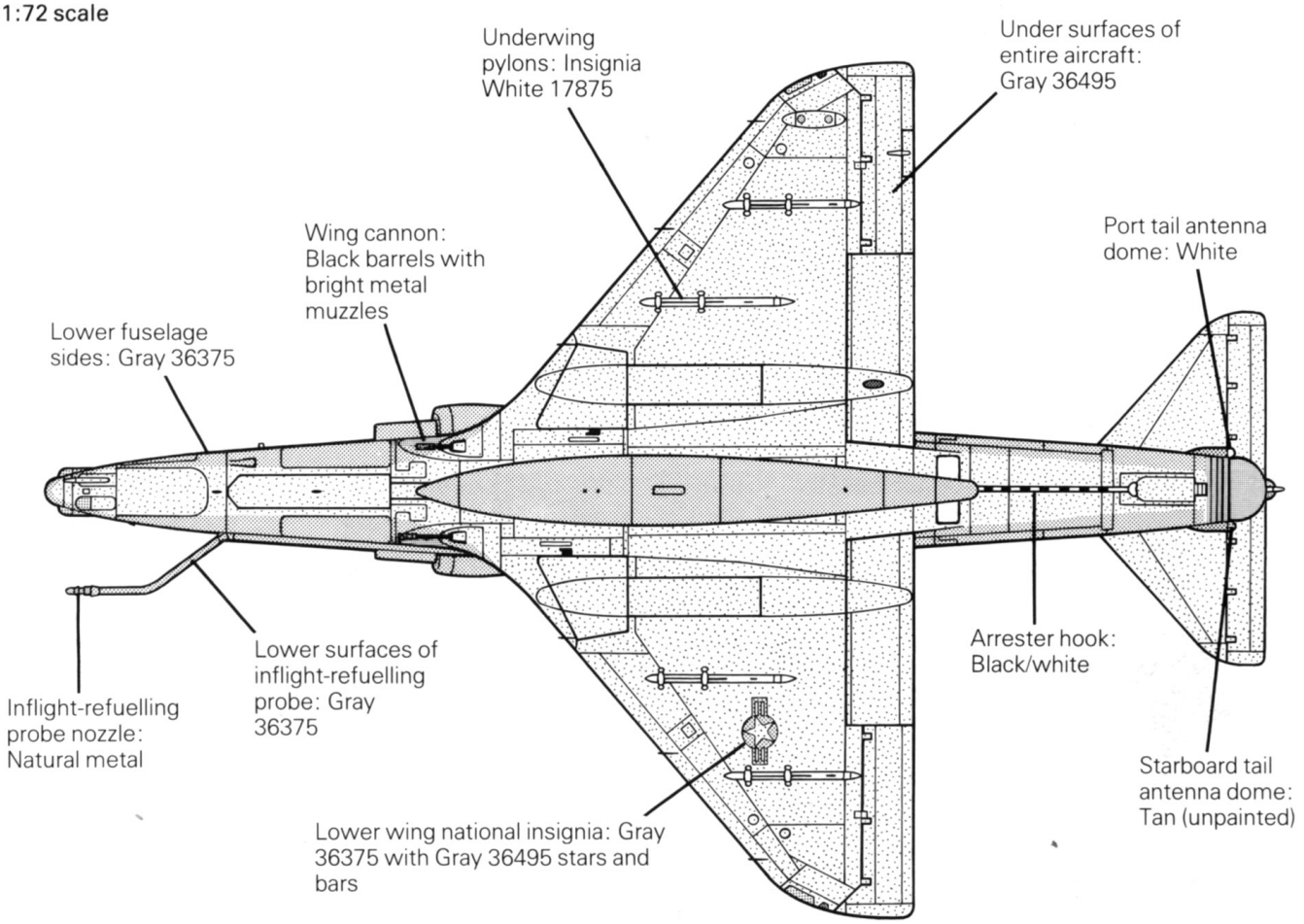


McDONNELL DOUGLAS A-4M SKYHAWK, VMA-311, 3rd MAW, MCAS EL TORO, MAY 1985

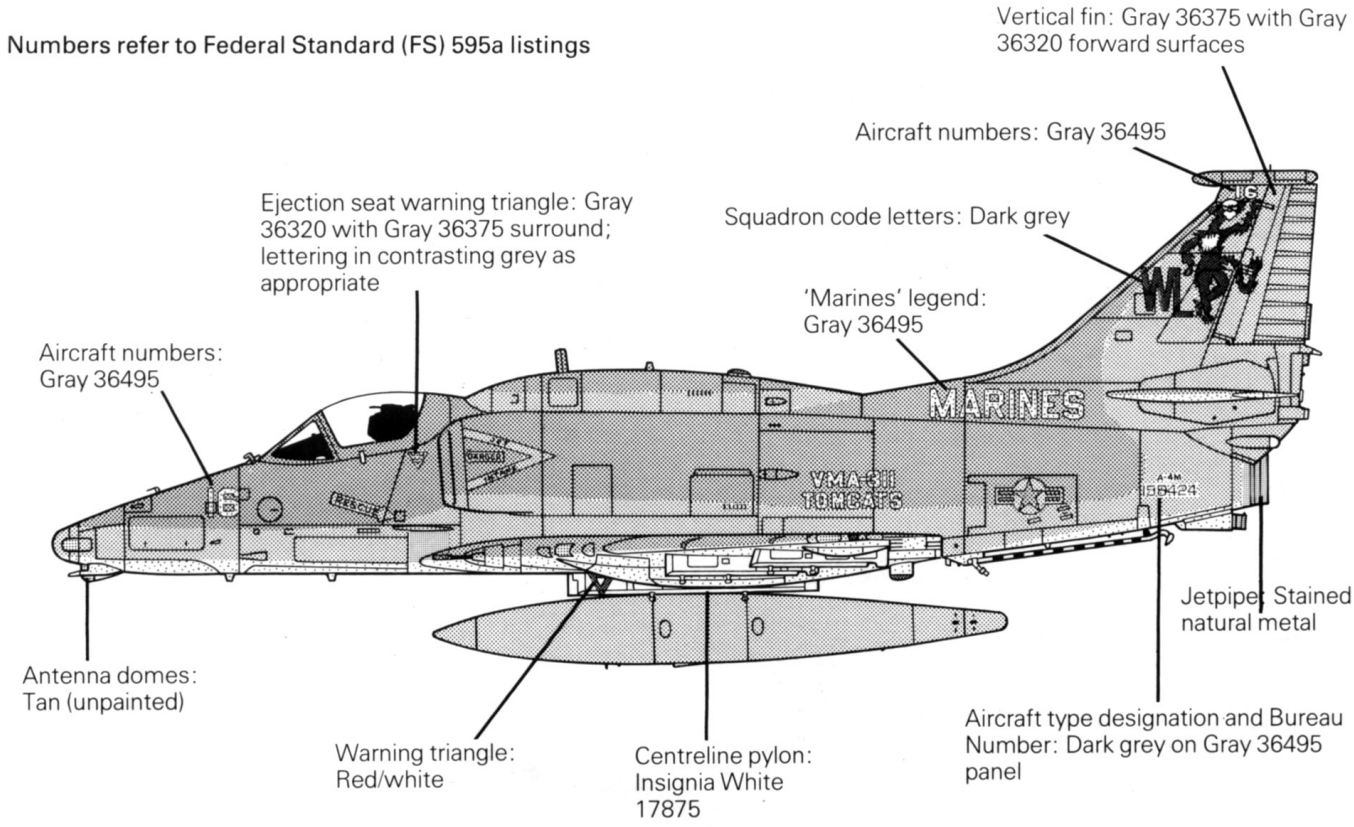




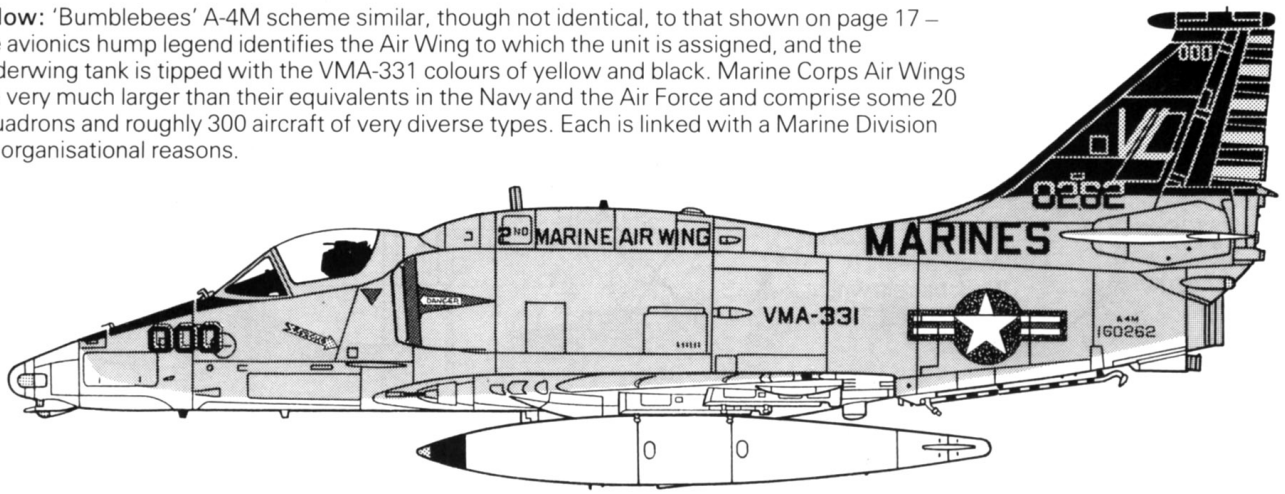
1:72 scale

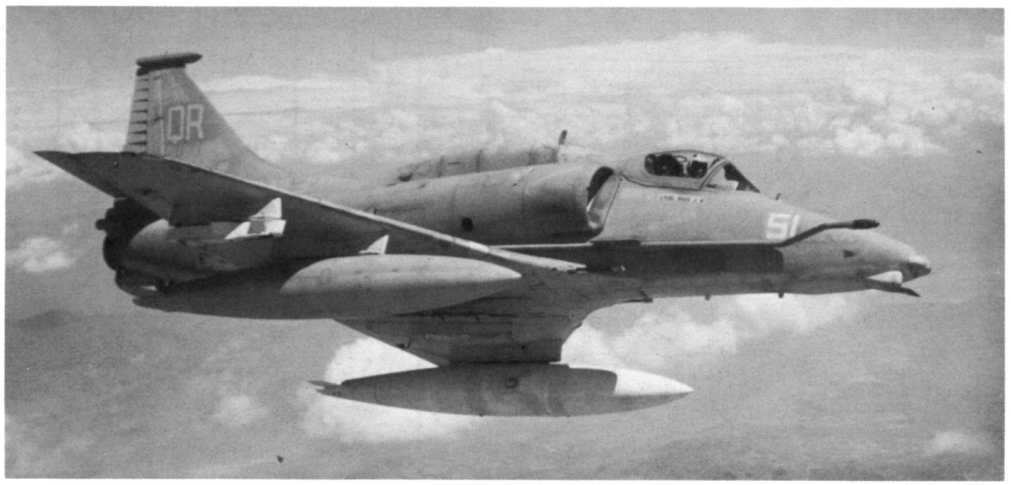


Numbers refer to Federal Standard (FS) 595a listings

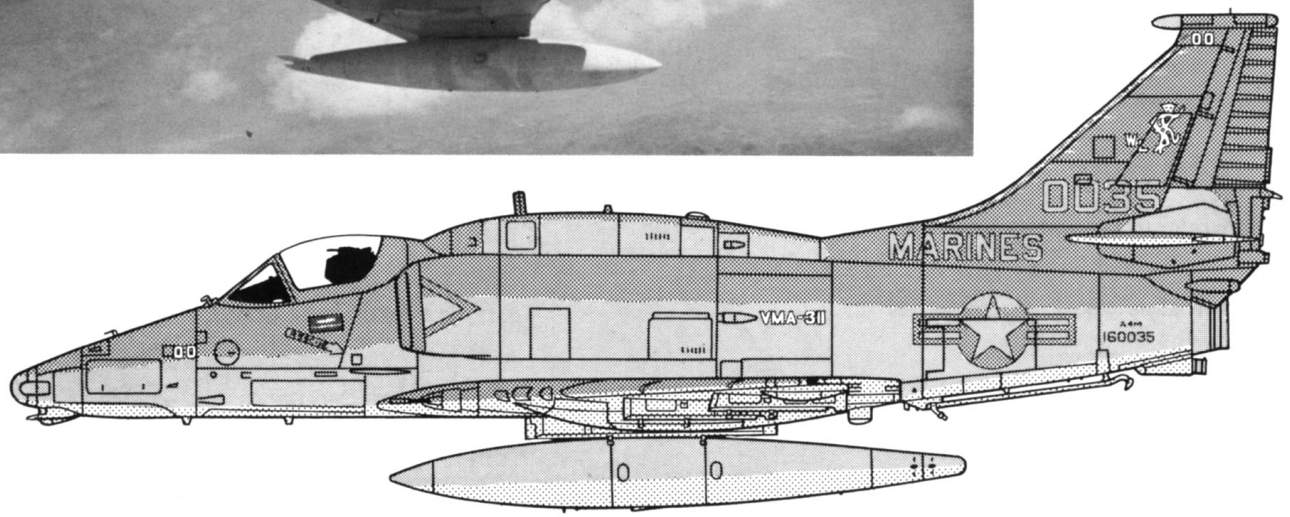


Below: 'Bumblebees' A-4M scheme similar, though not identical, to that shown on page 17 – the avionics hump legend identifies the Air Wing to which the unit is assigned, and the underwing tank is tipped with the VMA-331 colours of yellow and black. Marine Corps Air Wings are very much larger than their equivalents in the Navy and the Air Force and comprise some 20 squadrons and roughly 300 aircraft of very diverse types. Each is linked with a Marine Division for organisational reasons.





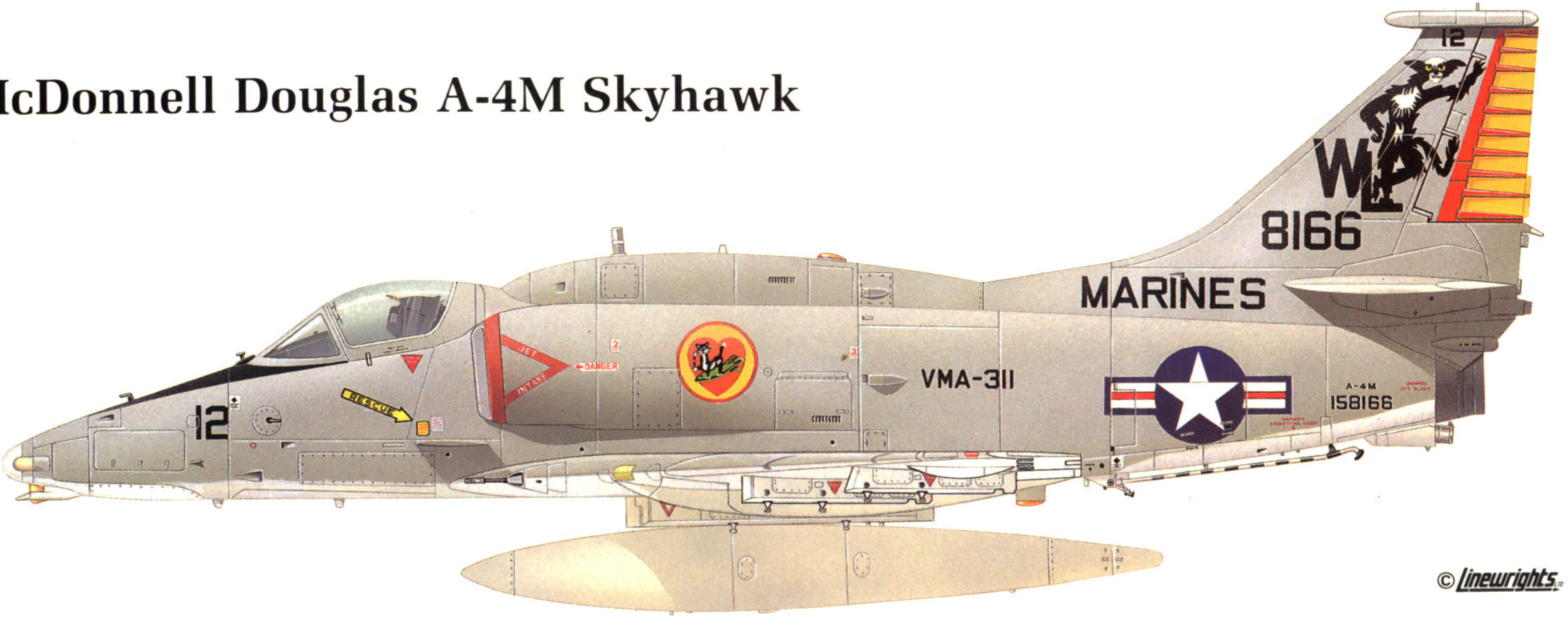
Left: A 1983 photo showing a VMA-332 (Reserve Force) A-4M up from MCAS South Weymouth. The aircraft is in three-tone grey finish, although the port underwing tank is painted in the old Insignia White, which colour is also used for the aircraft number on the nose. *Harry Gann/McDonnell Douglas*

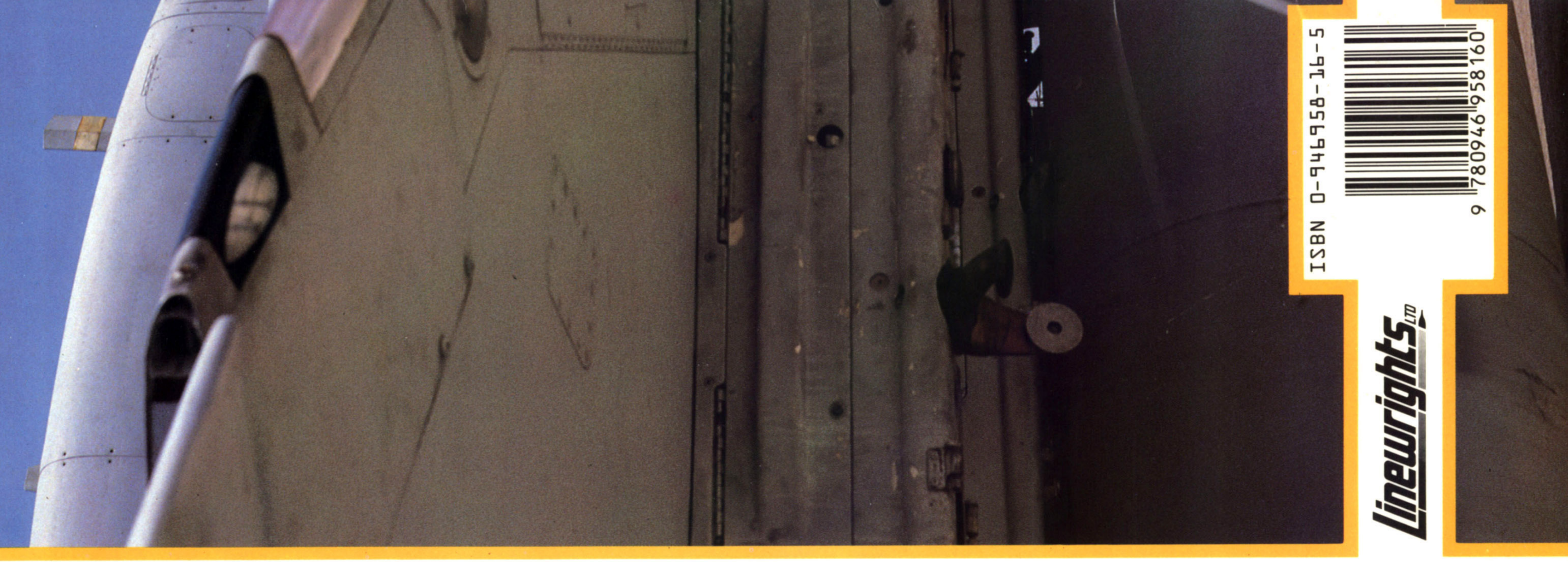


Above: A 'Tomcats' A-4M finished in greys 36293 (upper surfaces), 36440 (sides) and 36559 (lower surfaces), in a 1982 scheme different again from the other low-visibility VMA-311 Skyhawks shown in this book. All squadron-applied markings are white, and note the red instruction panel beneath the cockpit. Arrester hook is 36559.

Left: A very well-worn and patched-up tactical scheme adorns this VMAT-102 A-4M, with squadron decor in black and '02' on nose and fin top in white. *Harry Gann/ McDonnell Douglas*

McDonnell Douglas A-4M Skyhawk





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